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Remediation of Condemn Oil Polluted Loamy Soil Using Azadirachta Indica (Neem)

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Abstract

The remediation of condemn oil polluted loamy soil using neem (azadirachta indica) was investigated. The neem leaves came from Akpugo in the southeast Nigerian state of Enugu State's Nkanu West local government area. The leaves were dried at room temperature and subjected to grinding machine to obtain the powdered form of the dried leaves that serve as treatment to remediate condemn oil polluted loamy soil. Three masses 5 g, 10 g and 15 g of the powdered Azadirachta indica were measured in the ratio of 1:2:3 respectively and added in the mixtures. The analysis for characterization of individual hydrocarbons in the condemn oil and the mixture of soil, azadirachta indica and condemn oil were carried out. The concentration of the first members of the three families n-octane (C8), n-icosane (C20) and n-triacontane (C30) identified were determined weekly for three weeks cure. The plot of concentration of total petroleum hydrocarbon (TPH) against time rapidly decreased in the concentrations of the first members of the three families' n-octane, n-icosane and n- triacontane with respect to time in days in the increasing order of masses azadirachta indica as 5 g > 10 g > 15 g and the plot of concentration of total petroleum hydrocarbon (TPH) against the masses of azadirachta indica there was rapid decrease of the concentration of (TPH) with the masses of azadirachta indica in increasing order of time as 7 days > 14 days > 21 days. From the result obtained the following recommendations were made: Neem is recommended for remediation of condemn oil and related products in loamy soil and other soil environment in general, government at all level should establish plant for the manufacturing of neem powder and neem is recommended to all oil companies for oil spillage control.

Keywords: Hydrocarbon Degradation, Remediation, Condemn Oil, Polluted Soil, Environment and Azadirachta Indica.

INTRODUCTION

An important problem facing the Niger Delta is oil spills on land. Petroleum can find its way due to pipeline leaks and explosions, corrosion of subterranean pipes carrying crude oil, and the activity of oil exploration and exploitation carried out by multinational and domestic private companies. Petroleum products can also appear as untreated industrial waste Ukpaka CP, Udeh IE [1].

According to neem root extracts have been used to study the breakdown of crude oil in loamy soil. The degradation of total petroleum hydrocarbons (TPH) in loamy soil decreased across the process, but, higher in loamy soil with treatment in water solution with neem extract and also, the total petroleum hydrocarbons (TPH) degradation was determined, the response observed was promising degradation of pollutant in soil Ukpaka et al (2020) [2]. The experiment to assess the concentration of n-decane in crude oil diffusion in various soil

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environments. They found that as time increased, there was a decrease in the hydrocarbon degradation of n-decane (C10). It is possible to attribute the decrease to the order of magnitude of the individual hydrocarbon degradation and diffusion in the different soil samples, which showed that the behavior of the C10 individual hydrocarbon degradation in this case can be attributed to the physicochemical properties of the soil as well as the environmental factors. The decrease in sandy soil is greater than that of clay soil and loamy soil, while that of clay soil is greater than that of loamy soil Obire O, Nwaubeta O (2001) [3].

The performance of moringa and neem extracts on crude oil degradation in soil environment there was increased in degradation of total petroleum hydrocarbons (TPH) with increased in time in all the soil type. The effect of neem seed and turmic rhizome extracts on aphids control, plant control and yield in okro, said that plant growth and yield was observed on a regular basis Muhammad and others (2018) [4]. In Abakaliki, southeast Nigeria, the cleanup of soil contaminated by crankcase oil using several manure sources resulted in a significant ($P<0.05$) improvement. the impact of the treatment on the following factors: plant height, cation exchange capacity, accessible phosphorus, calcium, gravimetric moisture content, and grain yield of maize Nwite et al (2016) [5]. Using a mixed culture of Bacillus subtilis and Pseumomonas aeruginosa at several concentrations, Faggo et al. (2020) [6] assessed the breakdown of crude oil. At a crude oil concentration of 5%, the mixed culture broke down eighteen components, spanning from C10 to C25; degradation rates for C8 to C11 and C8 to C9 were 10% and 15%, respectively.

Azadirachta indica in two commercial formulations on their degradation under different temperatures and pH conditions by using high performance liquid chromatographic method and stated that the addition to both temperature and pH were significantly effective on degradation of azadirachta indica Hull Jr CJ et al (1993) [7]. The impact of post-harvesting and neem maturation on soil N and CO_2 emissions, bean growth, and some neem components, like azadirachtin, can negatively affect fungi and neutrifying bacteria, which can affect the soil's carbon (C) and nitrogen (N) cycles Montes – Molina et al (2008) [8].

In Gukari, northeastern Nigeria, the effects of engine oil-contaminated soil on various characteristics and microbial development were observed Udeh NU (2013) [9]. The contaminated soils showed substantial ($p < 0.05$) increases in organic carbon, organic matter, total nitrogen, and pH when compared to the control group, which did not receive any engine oil additions. 2019 saw Tanimu et al. (2019) [10].

MATERIALS AND METHODS

This part focuses attention on the materials, methods, and procedures used to carry out this research.

Materials

The materials used for the research are nine (9) equal containers of the same size as reactors, cylinder, loamy soil, condemn oil, weighing balance, measuring cylinder, spatula, Azadirachta indica, sample bottles, grinding machine and gas chromatography (G.C.) as shown in Figure 1.

Methods

Preparation of Azadirachta indica for Experiment

The leaves of azadirachta indica (Dogoyero) were obtained from the next compound at left- hand side of Faculty of Engineering Akpugo Campus of Madonna University Nigeria as shown in Figure 2. The leaves were washed with water and dried at room temperature (25°C) for some period of time let say three weeks. After confirmation that the leaves had dried, they were removed from the branches and subjected to grinding machine to obtain the smallest particles of the leaves. The grinded azadirachta indica was subjected to 0.5 µ filter to have the grinded leaves in powdered form that was used in the experiment.

Figure 1. The Materials for experimental set-up.

Figure 2. Azadirachta Indica Leaf.

Preparation of Condemned Oil used for the Experiment

The condemned oil used for the experiment was obtained from the oil removed from the generator serving the boys hostel of faculty of engineering Akpugo Campus Madonna University.

The Set-up of Experiment

Before the set – up of the experiment, the condemned oil obtained from the boy's hostel of the faculty of engineering Akpugo campus, Madonna University Nigeria was taking to BJ FADGRAS Nigerian Limited to test for the characterization of the Total Petroleum Hydrocarbon (TPH) present, which serves as the control. In setting-up the experiment, nine (9) empty containers of the same size were used as shown in Figure 3, 100 g of loamy soil was measured and transferred into nine containers of the same size. The compositions of Azadirachta indica were in the ratio of 1:2:3. Then, 5 g of the powdered Azadirachta indica was added to the soils in the first three sets. After that, 10 g of the powdered Azadirachta indica was measured and added to the soils in next three sets and finally 15 g of Azadirachta indica was measured and added to the soils in the last three sets. After adding the soils and Azadirachta indica, 20 cm^3 condemned oil was measured with the help of measuring cylinder and added to the nine containers with soils and Azadirachta indica, the three components, the soil, Azadirachta indica and condemned oil were mixed with the help of stirrer and kept in the Laboratory of Chemical Engineering Department Faculty of Engineering Akpugo Campus Madonna University Nigeria. In the first seven (7) days the first set, one from 5 g, 10 g and 15 g were taking to the company to test on three weeks cure.

Figure 3. Experimental Set-up of bioremediation of condemn oil in loamy soil using Azadirachta Indica.

Total Hydrocarbon Content THC by G.C (FID)

Sample Extraction

An amber glass bottle was filled with 10 ml of the sample. A stir was given to the sample. The sample was mixed with 300 μg/ml of surrogate (1-chlorooctadecane) standard. The sample was combined with 30 milliliters of dichloromethane (DCM) as an extracting solvent. The sample-containing bottle was then tightly corked and placed on a mechanical shaker. Using a mechanical shaker, the sample was agitated for five to six hours at room temperature. Following agitation, the material was filtered through 110 mm filter paper into a sterile beaker after being let to settle for one hour. The filtrate was allowed to evaporate in a fume cupboard for one night in order to concentrate to one milliliter.

Sample Clean-up

Glass columns were used for sample cleanup. Glass cotton was inserted into the column to prepare it for use. DCM was used to dissolve 10 g of silica gel into a slurry, which was then put into the column. Pentane was added to the column after 10 g of anhydrous Na_2SO_4 was added. Following column preparation, the concentrated sample extract was put into a beaker along with 20 milliliters of cyclohexane and then put into the column. Using pentane as the solvent, the sample extract was eluted, and the eluted sample was collected in a beaker beneath the column. By adding an additional 30 milliliters of pentane to the column, the material was further eluted. A 20 ml DCM rinse was applied to the column following elution. In order for evaporation to occur, the eluted sample was left to stand at room temperature for the entire night in a fume closet.

Sample Separation and Detection

The Agilent 6890N Gas Chromatograph - Flame Ionization Detector (GC-FID) instrument was used to separate and detect the chemicals in the groundwater samples. A GC vial was filled with 3 μl of the concentrated sample that was eluted from the column. Before removing the sample for analysis, the GC micro syringe was cleaned three times with the injection of blank DCM. The sample was used to further rinse the micro syringe. Subsequently, the sample was introduced into the column in order to separate its constituent components. The chemicals were run through a flame ionization detector following separation. The chemicals in the sample are found using FID. TPH concentration was determined at a certain chromatogram in milligrams per liter.

RESULTS AND DISCUSSIONS

Graph of Concentration Against Azadirachta Indica and Time of Octane, Icosane and Triacontane

Figure 4 illustrates the relationship between concentrations of C_8 individual hydrocarbon degradation in reactors containing the mixture of 100 g of loamy soil, azadirachta indica in the ratio of 1:2:3 and 20 ml of condemn oil with time. As time increased, a decrease in the concentration of C8 individual hydrocarbon degradation was seen. The order of magnitude in terms of C_8 individual hydrocarbon degradation in mixture was examined and the result obtained revealed that 5 g > 10 g > 15 g indicating the significance of neem (azadirachta indica) remediating the condemn oil in the loamy soil with respect to increase in time.

Figure 5 shows the relationship between concentrations of C_8 individual hydrocarbon degradation in reactors containing the mixture of 100g of loamy soil, azadirachta indica in the ratio of 1:2:3 and 20 ml of condemn oil with Neem (azadirachta indica). Decrease in the concentration of C_8 individual hydrocarbon degradation was observed with increase in azadirachta indica. The order of magnitude in terms of C_8 individual hydrocarbon degradation in mixture was examined and the result obtained revealed that 7 days > 14 days > 21 days indicating the significance of neem (azadirachta indica) remediating the condemn oil in the loamy soil with respect to increase in quantity of neem (azadirachta indica).

Figure 6 illustrates the relationship between concentrations of C_{20} individual hydrocarbon degradation in reactors containing the mixture of 100 g of loamy soil, azadirachta indica in the ratio of

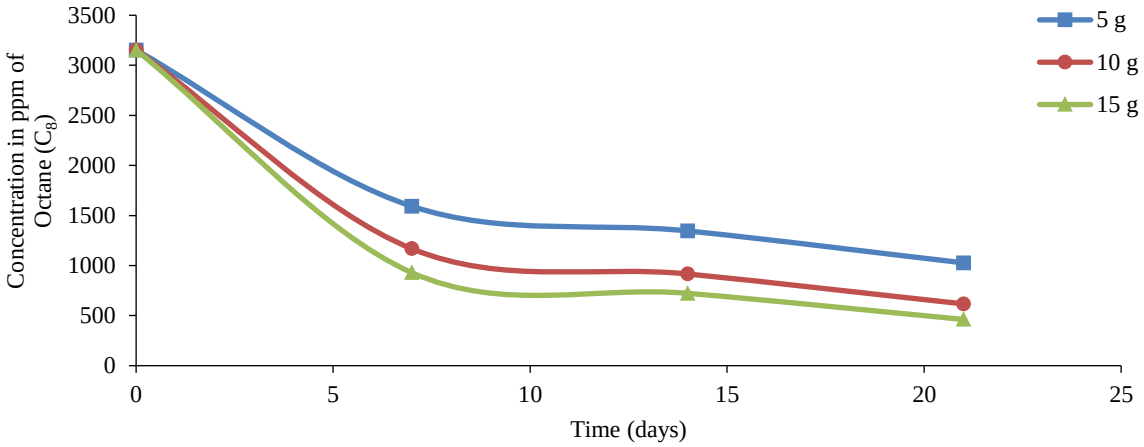

Figure 4. Graph of concentration of C_8 degradation versus time for loamy soil.

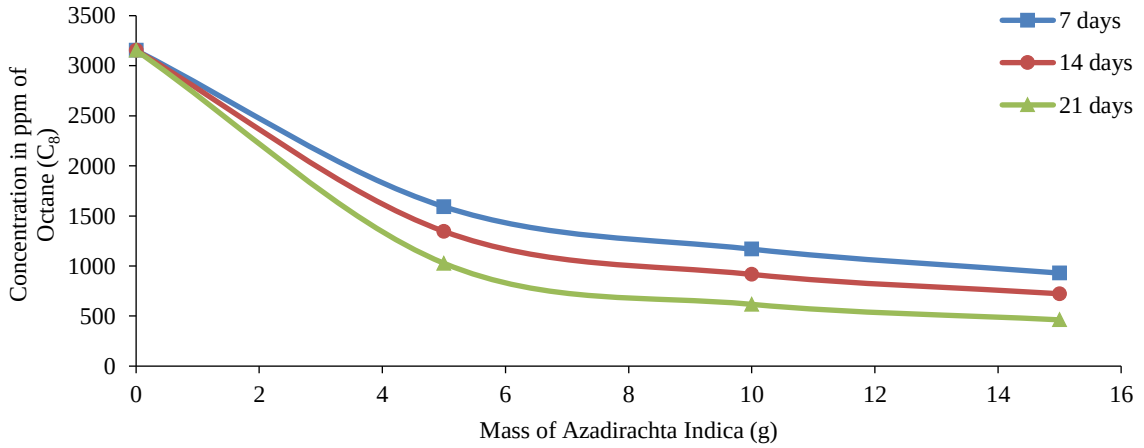

Figure 5. Graph of concentration of C_8 degradation versus mass of neem (Azadirachta indica) in loamy soil.

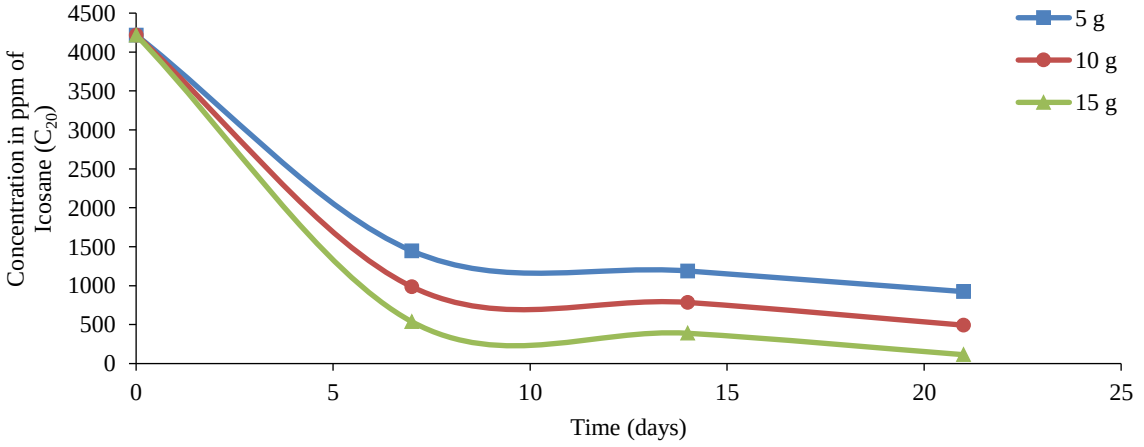

Figure 6. Graph of concentration of C_{20} degradation versus time for loamy soil.

1:2:3 and 20 ml of condemn oil with time. As time increased, a decrease in the concentration of C20 individual hydrocarbon degradation was seen. The order of magnitude in terms of C_8 individual hydrocarbon degradation in mixture was examined and the result obtained revealed that 5 g > 10 g > 15 g indicating the significance of neem (azadirachta indica) remediating the condemn oil in the loamy soil with respect to time.

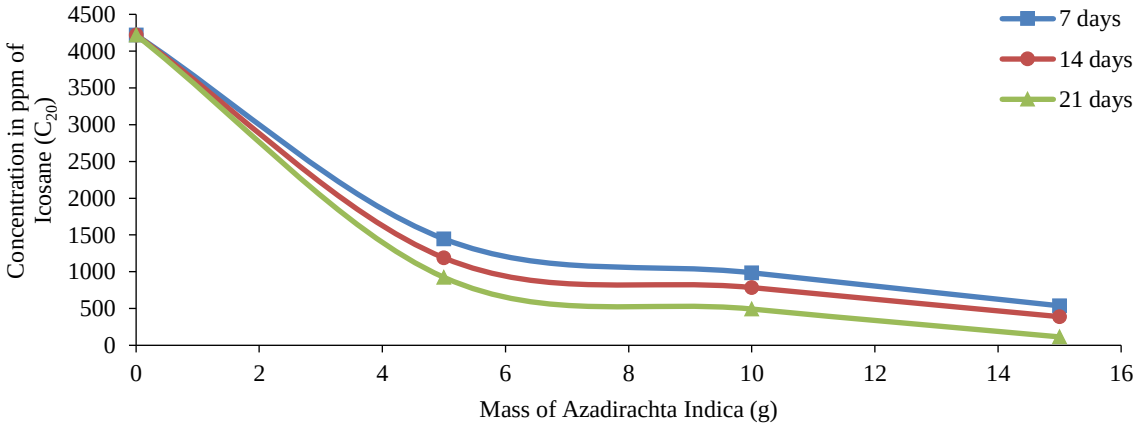

Figure 7. Graph of concentration of C_{20} degradation versus mass of neem (azadirachta Indica) in loamy soil.

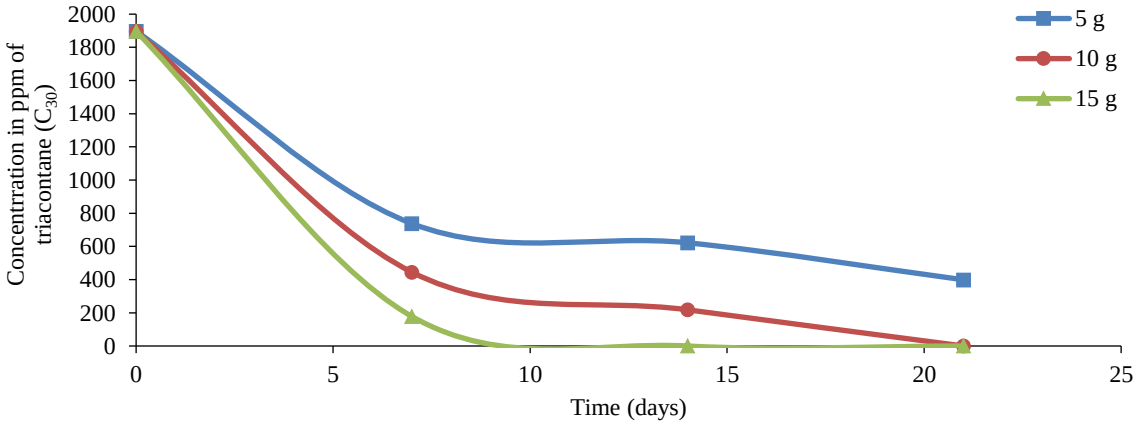

Figure 8. Graph of concentration of C_{30} degradation versus time for loamy soil.

Figure 7 shows the relationship between concentrations of C_{20} individual hydrocarbon degradation in reactors containing the mixture of 100 g of loamy soil, azadirachta indica in the ratio of 1:2:3 and 20 ml of condemn oil with Neem (azadirachta indica). Decrease in the concentration of C_{20} individual hydrocarbon degradation was observed with increase in azadirachta indica. The order of magnitude in terms of C_{20} individual hydrocarbon degradation in mixture was examined and the result obtained revealed that 7 days > 14 days > 21 days indicating the significance of neem (azadirachta indica) remediating the condemn oil in the loamy soil with increase in the quantity of azadirachta indica.

Figure 8 depicts the relationship between concentrations of C_{30} individual hydrocarbon degradation in reactors containing the mixture of 100 g of loamy soil, azadirachta indica in the ratio of 1:2:3 and 20 ml of condemn oil with time. With increasing time, there was a decrease in the concentration of C30 individual hydrocarbon degradation. The order of magnitude in terms of C_8 individual hydrocarbon degradation in mixture was examined and the result obtained revealed that 5 g > 10 g > 15 g indicating the significance of neem (azadirachta indica) remediating the condemn oil in the loamy soil with respect to time.

Figure 9 shows the relationship between concentrations of C_{30} individual hydrocarbon degradation in reactors containing the mixture of 100 g of loamy soil, azadirachta indica in the ratio of 1:2:3 and 20 ml of condemn oil with Neem (azadirachta indica). Decrease in the concentration of C_{30} individual hydrocarbon degradation was observed with increase in azadirachta indica. The order of magnitude in terms of C_{30} individual hydrocarbon degradation in mixture was examined and the result obtained revealed that 7 days > 14 days > 21 days indicating the significance of neem (azadirachta indica) remediating the condemn oil in the loamy soil with increase in the quantity of azadirachta indica.

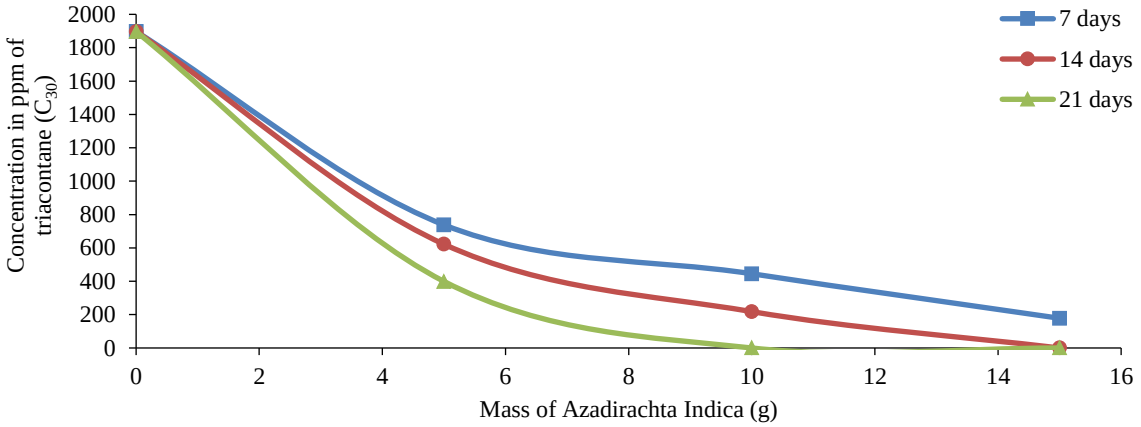

Figure 9. Graph of concentration of C_{30} degradation versus mass of neem (azadirachta Indica) in loamy soil.

CONCLUSION

The concentration of n- octane, n-icosane and n-triacontane decreases rapidly with time in order of magnitudes of C_8, C_{20}, and C_{30} hydrocarbons degradation as 5 g > 10 g > 15 g. The concentration of C_8, C_{20}, and C_{30} with respect to the quantity (mass) of azadirachta indica (neem) decreases with increases in the quantity of neem in order of magnitudes of C_8, C_{20}, and C_{30} hydrocarbons degradation as 7 days > 14 days > 21 days.

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