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Introduction

Petroleum is a complex mixture of di erent hydrocarbons including aliphatic, cycloalkanes, mono and polyaromatics, asphalthenes and resins with majority of these compounds toxic and carcinogenic [1]. e increasing worldwide demand for energy from petroleum and an increase in prospecting for crude oil in the marine environment would mean a higher risk of accidental oil discharge into the marine environment [2,3].

e Niger Delta region of Nigeria has witnessed an intermittent discharge of crude oil into its environment since the inception of crude oil exploration and exploitation, this has led to the destruction of its farmlands, aquaculture, rivers and creeks with hydrocarbon compounds [4].

Recently they have been an increasing agitation to cleanup, reclaim and restore all oil polluted environments within the Niger Delta [5]. Bioremediation is said to be the best approach for environmental clean up because it is a cost e ective and an eco friendly strategy. However in moderate to highly saline environments like the marine environment, application of bioremediation is very challenging due to the detrimental e ect of salt on microbial life. e salty nature of the environment could even be compounded by produced water, a byproduct or waste associated with oil and gas production which contains high levels of salt (1000-250,000 mg/L), oil and grease, toxic chemicals, heavy metals, and naturally occurring radioactive materials [6,7]. erefore in other to e ectively carryout bioremediation in such

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environments a di erent bioremediation approach has to be applied. is approach would involve the use of halophilic and halo-tolerant microbial species capable of e ectively degrading hydrocarbons under high salt conditions. Halophiles are classi ed into three groups according to their optimal salt concentration for growth: slightly halophilic (1-3% w/v), moderately halophilic (3-15% w/v), and extremely halophilic (15-32% w/v) [7-9]. Many hydrocarbon degrading organisms are known [10] and in the marine environment a number of specialist hydrocarbon degrading taxa are also known [1,11]. Aromatic hydrocarbon degraders include spp. which

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sodium sulphate layer to air. Accurately measured volume of 8-10 ml of the eluent was collected and labeled Aliphatic.

Following recovery of the aliphatic fraction and just prior to exposure of the sodium sulphate layer, the column was eluted with 1:1 mixture of acetone and methylene chloride in 1-2 ml increments. Another accurately measured 8-10 ml of the eluent was collected and labeled ''Aromatics". e aromatic fraction was concentrated to 1 ml for PAHs analysis using gas chromatography.

Bioreactor design and operation

Bioremediation of hydrocarbon-contaminated sediments from Bodo creek was carried out using seven 2.5 L bioslurry bioreactors operated over a 64-day period. Two reactors served as controls (unamended) and (heat-killed), four out of the remaining ve as nutrient amended bioreactors while one was amended with 10 cfu/g consortium of indigenous hydrocarbon utilizing bacteria. e bioreactors were designated as BPD, BCD, BUR, BNPK, BAUG, BUNa and BHK (Poultry dropping, Cow dung, Urea, NPK, consortium of indigenous hydrocarbon utilizing bacteria, unamended control and heat killed control respectively). Each of the 7 bioreactors received 1 kg (wet weight) of sediments, 20 ml of crude oil and 20 mg of anthracene. For the controls, the unamended treatment was spiked with hydrocarbons without nutrient addition to determine whether the indigenous bacteria have the natural ability to degrade petroleum hydrocarbons, whereas the heat-killed treatment (killed by autoclaving sediments at 121°C for 15 min at 15 psi on 2 consecutive days) served to measure the role of abiotic factors in the loss of petroleum hydrocarbons. e bioreactors were continuously stirred (by 2 impellers) at 150 rpm throughout the 64-day experimental period. Filtered air was supplied to the bioreactors from the air compressor through hoses running in and out of them. e reactors were sealed with Te on to prevent the ingress of atmospheric air and egress of the slurry. roughout the 64-days of experimentation the reactors were operated at room temperature (30°C).

Microbiological analysis of samples

Enumeration of total culturable heterotrophic bacteria (TCHB): 1 g (wet weight) of sediment was homogenized in 0.85% of normal saline. Decimal dilutions (tenfold) of the suspensions was plated out

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