Fermentation Technology
ISSN: 2167-7972

Owhonka and Gideon, Fermentol Techno 2015, 4:2
DOI: 10.4172/2167-7972.1000122

Short Communication Open Access

The Role of Aerobic Microorganisms in the Biodegradation of Petroleum Hydrocarbons Laboratory Contaminated Groundwater

Owhonka A* **and Gideon OA**

Department of Microbiology, Faculty of Biological Sciences, School of Natural and Applied Sciences, University of Port Harcourt, P.M.B.5323, Port Harcourt, Rivers State, Nigeria

***Corresponding author:** Owhonka A, Department of Microbiology, Faculty of Biological Sciences, School of Natural and Applied Sciences, University of Port Harcourt, Rivers State, Nigeria; E-mail: owhonka@yahoo.com.

Received date: Jul 15, 2015; **Accepted date:** Nov 13, 2015; **Published date:** Nov 18, 2015

Abstract

The total hydrocarbon content removal in nutrient amendment and natural attenuation at day 56 showed percentage removal of 89 and 74, respectively. Total heterotrophic and total hydrocarbon utilizing bacterial count increased progressively in all the treatment options. The nutrient amendment showed greater removal of the hydrocarbon pollutants. The physicochemical analyses at day 56 were within the World Health Organization standard for drinking water.

Keywords: Aerobic biodegradation; Petroleum hydrocarbon; Groundwater; Nutrient amendment; Natural attenuation

Short Communication

Groundwater is an important source of water for agricultural and domestic use especially in developing countries like Nigeria, due to long retention time and natural filtration capacity of aquifers [1]. It is less contaminated as compared to surface water [2]. However petroleum hydrocarbons can be introduced into groundwater via oil spills, leaking or unplugged oil wells, the disposal ponds of waste petroleum products, abandoned oil refinery sites, pipe line ruptures, incomplete combustion of fossil fuels and accidental discharge during transport in tanks and ships failures [3].

In the present study, degradability of hydrocarbon, organisms involved and the physicochemical characteristics of the laboratory contaminated groundwater under natural attenuation and biostimulation conditions were determined.

In the course of the research it was also observed that the groundwater sample Treated (Nutrient amendment) showed a higher percentage removal of the total hydrocarbon content (89%) compared to un-Treated (natural attenuation) which showed 74% removal at the end of the fifty six days. The contributions of natural attenuation to the bioremediation of impacted media such as water have been reported at other times too [5].

Bioremediation can be effective only where environmental conditions permit microbial growth and activity. In some cases, the environment can be modified to support or accelerate microbial growth, for example, by fertilizer application [6]. The benefit of nutrient amendment was also observed by Abu and Ogiji (1996), who noted that the response of the indigenous hydrocarbon degrading microorganisms to the bioremediation treatment was positive and differed according to the type and concentration of the nutrients added.

The increase in counts of the heterotrophic population is in agreement with results obtained by other researchers that hydrocarbon pollution does not enrich only hydrocarbon utilizers but also other populations that utilize breakdown products of hydrocarbons [7]. The growth in the heterotrophic count and hydrocarbon utilizing bacteria were also observed to be more in nutrient amendment sample than untreated sample as the experiment progressed. Other researchers [8,4,5] have also demonstrated the use of inorganic nutrients in bioremediation of hydrocarbon impacted media with overall positive results.

Generally, it is believed that microbes preferably degrade or metabolize C_8-C_{15} nalkanes followed by C_{16}-C_{36} n- alkanes due to simplicity of these hydrocarbons [9]. Most of the sharp peaks observed in the original sample were either reduced or not found in the Treated sample after fifty six days.

The observed pH values throughout the study are of special consideration since microbial populations are highly dependent on this parameter [10]. The results are in agreement with observation made by other workers that a pH range of 6-8 provides better conditions for mineralization of hydrocarbons since most bacteria capable of metabolizing hydrocarbons develop best at pH conditions close to neutral [10].

The dissolved oxygen concentrations measured in the flasks in the course of the study were lower than the initial concentration of 8.0 mg/l. Oxygen is a microbial electron acceptor and a redox indicator. High oxygen (>2 mg/L) shows aerobic conditions and oxygen will be the preferred electron acceptor until depleted. Nutrient amendment enhanced oxygen uptake.

The reduction in conductivity in treated and un-treated sample from initial of 63 µs/cm to 43 µs/cm and 63 µs/cm to 26 µs/cm after fifty six days, respectively suggests that there was uptake and exchange of ions in the samples in course of the study confirming that biodegradation of hydrocarbon was achieved. The maximum permitted conductivity by Nigerian Standard for drinking water quality is 1000 µs/cm [11].

The reduction of these nutrients as the experimental period progressed suggests utilization by microorganisms.

These results clearly show that a large diverse aerobic bacterial population capable of utilizing organic carbon is present in groundwater.

References

1. Odukoya OO, Arowolo TA, Bamgbose O (2002) Effect of solid waste landfill on underground and surface water quality at Ring road, Ibadan. Global J Environ Sci 2: 235-242.

2. Aiyesanmi AF, Ipinmoroti KO, Oguntimehin II (2004) Impact of automobile workshop on groundwater quality in Akure Metropolis. J Chem Soc Nig (Supplement to 2004 Proceeding), pp. 420-426.
3. Kharaka YK, Hanor JS (2003) Deep fluids in the continents: I. Sedimentary basins, in Drever JI ed, Treatise on Geochem 5: 499-540.
4. Abu GO, Dike PO (2008) A study of natural attenuation processes involved in a microcosm model of a crude oil-impacted wetland sediment in the Niger Delta. Bioresour Technol 99: 4761-4767.
5. Abu GO, Ofurum K (2006) A preliminary investigation of the involvement of natural attenuation processes in the fate and transport mechanism of phenol in a refinery effluent in the Niger Delta. Global Journal Pure and Applied Science 12: 327-333.
6. Atlas RM, Bartha R(1992) Hydrocarbon biodegradation and oil spill bioremediation. Advances in microbial Ecology. Premium Press 12: 287-338, New York.
7. Bartha R, Atlas RM (1998) Microbial ecology: Fundamentals and Applications (4thedn.). Benjamin/Cummings, New York, pp. 523-530.
8. Abu GO, Atu ND (2008) An investigation of oxygen limitation in microcosm models in the bioremediation of a typical Niger Delta soil ecosystem impacted with crude oil. Journal Applied Science and Environmental Management 12: 13-22.
9. Deppe U, Richnow HH, Michaelis W, Antranikian G (2005) Degradation of crude oil by an arctic microbial consortium. Extremophiles 9: 461-470.
10. Manuel-Prado J, Correa M, RodriguezGnaw J, Carneiro M (1993) Oily sludge land farming biodegradation experiment conducted at a tropical site in Eastern Venezuela. Waste Management Research 11: 97-106.
11. Nigerian Industrial Standard (NIS) 554:2007.Nigerian Standard for Drinking Water Quality.ICS 13.060.20. Price group D SON pp: 1-30.