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Bioremediation of the water contaminated by waste of hydrocarbon by use Ceratophyllaceae and Potamogetonaceae plants

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Abstract

Through this study hydrocarbon residues in water removed, the treatment take place during two stages spent 40 days (the first phase includes Bio-augmentation to make biodegradable water by adding 5 ml of coliform bacteria which had been taken from Al Dura oil refinery. This study has decline oil content from 26.8 ppm to 4.5 ppm in water contaminated by hydrocarbon, and then the second phase of plant treatment begins using two types of plant (*Ceratophylum* and *Potmogen).* Phytoremediation Showed that Ceratophylum best efficient than *Potmogen* In the absorption of hydrocarbon compounds, the *Ceratophylum* plant reach 8.8ppm if compared with *Potmogen* reach 5.7ppm.

Key Words: Bioremediation, Waste of hydrocarbon, Ceratophyllaceae, Potamogetonaceae, Iraq

Introduction

The waste of hydrocarbon considered from the dangerous material which bluster the environment , its produced by many industrial operation like the oil rectification and electric generator, the researcher try to find new way for treatment this Waste, and give the priority to be more save and cheap . From this way the biotical treatment and it's more comprehension for a lot of way of bioremediation.

Petroleum hydrocarbons pollutions, ranging from soil, ground water to marine environment, become an inevitable problem in the modern life (Abdulrahim and Gaber, 2010). Crude oil is a complex mixture of many compounds such as alkanes, aromatics, resins and asphaltenes (Płaza *et al.,* 2008). Bioremediation has been accepted as a cost-effective and important method for the treatment of oil-contaminated sites (Xueqing *et al.,* 2004). The most important principle of bioremediation is that microorganisms can be used to destroy hazardous contaminants or transform those to less harmful forms (Zulfiqar and Safia, 2012). Biodegradation in aquatic environment is limited by the availability of nutrients such as nitrogen and phosphorous, which are necessary for initial microbial cell growth (Rengathavas *et al.,* 2011). Numerous genera of bacteria are known as good hydrocarbon degraders. They tolerate high concentrations of the hydrocarbons and have a high capability for their degradation. Most of them belong to *Pseudomonas*, *Sphingomonas*, biodegradation in aquatic environment is limited by the availability of nutrients such as nitrogen and phosphorous, which are necessary for initial microbial cell growth (Rengathavas *et al.,* 2011). Numerous genera of bacteria are known as good hydrocarbon degraders. They tolerate high concentrations of the hydrocarbons and have a high capability for their degradation. Most of them belong to *Pseudomonas*, *Sphingomonas*, *Aeromonas*, *Alcaligenes*, *Acinetobacter*, *Arthobacter*, *Brevibacterium*, *Xantomonas*, *Mycobacterium*, *Rhodococcus* and *Bacillus* species (Dilsad *et al.,* 2011).

Phytoremediation is a broad term that has been in use since 1991 to describe the use of plants to reduce the volume, mobility, or toxicity of contaminants in soil, groundwater, or other contaminated media. It is an emerging green technology that can be a promising solution to remediate hydrocarbon-polluted soils, not only in

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developed countries but also in developing countries, in which uncontrolled disposal of oil industry wastes has polluted soil resources over the past decades (NJOKU, 2009). Successfully to degradable crude oil used the bacterial consortium prepared with 15 bacteria isolated by enrichment technique from the sample collected from an oil contaminated site. The biotic removal of alkanes (Zulfiqar and Safia, 2012).

Materials and Methods

Establish Treatment System and Collection of Water Samples: The design and implementation of the water treatment system in the workshops of Directorate Water and Environment in Ministry of Science and Technology /Iraq. This system with dimensions 150*70*75 cm3 in addition to the light supporting and oxygen unit. The water samples collected from oil refinery factory from Al-Doura. Furthermore, the system of oil refinery factory Doura within three stages of treatments.The water samples collect from oil refinery factory Al-Doura. Furthermore, the system of in oil refinery factory Doura within three stages of treatments. First mechanical stage physiochemical stage and biological stage. The water collected from second stage and distribute as equal in pools with dimensions 35*25*21cm^3 and fit the zero time for biodegradable.

Water physico-chemistry: Water temperature and pH were measured *in situ* using a mercury bulb thermometer and a portable pH meter respectively (WQMM, 2008). Other parameters such as turbidity, nitrate content, conductivity, total suspended solids, total dissolved solids, the acidity and total hardness were determined using standard analytical procedures.

The bioaugmentation process: The bioaugmentation carried out 25 days included the biodegradeable process, when added 5 ml from bacteria solution mixed with sludge that got from oil refinery factory Doura, and measured the oil content, BOD and COD (WQMM, 2008).

The BOD and COD Measurement: Prepared the heater until arrived to 150 C°, then put 2 ml from distilled water in the kit (2000) and 2 ml from the water contaminate in the same kit. Both kits let in the heater for 90 minute, after that above from the heater and let the temperature decrease until 40 C°. Last mission measured in the (COD) photometer 7100. For BOD tests achieved by BOD bottles in the laborites of Environmental and Water Research and Technology Directorate.

Isolated bacteria: Isolated bacteria from the water contamined by waste hydrocarbon, cultured on nutrient agar as a primary culture and made sub-culture for many times. Until got the pure colonies and diagnosed morphological by light Microscope and others biochemical tests, the genus was *Bacillus*.

Measurement of Phosphate and nitrogen content

The Phosphate and Nitrogen content measured by methods of soil analysis (Abdulrahim and Gaber, 2010).

The phytoremedation process: The phytoremedation process achieved by dispersed the plant (ceratophyllum and potomogen) on pools contained water after Biodegradation and measurements the oil content (AOAC, 1980).

Results and Discussion

Physico-chemistry of water contaminated by hydrocarbon: The results show the first test of Physico-chemistry of the water in Table (1), it bring from oil refinery factory Doura.

Table (1): Physico-chemistry of contaminated water by hydrocarbon

Parameter	Result	Standard
Temperature	32	28.7 ± 0.53C°
pH	8.64	6.8 ± 0.13
Turbidity	4.3	0.463±0.031 NTU
OIL content	26.8	7.07 ppm
TDS	118	519.25 ± 38.63 mg/L

For a successful bioremediation technique on a contaminated ecosystem, adequate knowledge of the physical and chemical properties of the contaminated site is a requirement (Cortez *et al.,* 2010). These factors have direct influence on the type, number and metabolic activities of the microflora of any ecosystem. The physico-chemistry of the water from where the microorganisms used in this study were isolated as summarized in Table 1 showed that the temperature was less high the mesophilic range (28.7±0.53C°), an ideal temperature for biodegradation of petroleum hydrocarbon in aquatic environment. Also, the pH never observed below 7.8, values obtained were generally above 8.6 (Adebusoye, 2008). The increasing trend of indiscriminate discharge of Hydrocarbon waste into the Water owing the higher usages of the water through the refinery Diesel (Chikere *et. al.,* 2009).

The population densities of hydrocarbon-utilizers and proportion of occurrence within the heterotrophic population was very high (26.8%) (Adebusoye, 2008).this assertion is further reflected in the previous work of in which the authors reported the proportions of hydrocarbon-utilizers. The higher proportion reported in the present study may be explained by the unquantifiable amounts of petroleum and associated products discharged indiscriminately into the water. This trend is likely to continue unless adequate monitoring and regulatory acts are put in place. Substrate spectral of the isolates utilized in this study revealed growth sustainability on diverse petroleum products and pure hydrocarbons (Adebusoye, 2008).

The Measurement of phosphate and nitrogen: The phosphorus and nitrogen content of the basic elements Where they are taking 150 ml of water treatment for the purpose of examining the content of phosphorus and nitrogen the results showed a clear reduction in the nitrogen content of 35.2 to 0.001, and for phosphorus from 2.8 to 1.5, and to sustain biological treatment Added source of phosphorus and nitrogen continuously to maintain the effectiveness of the bacteria in the decomposition process.

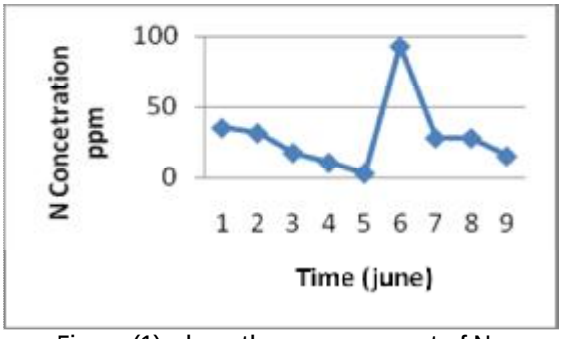

Figure (1): show the measurement of N

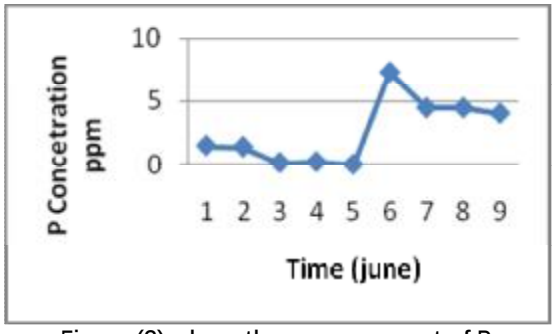

Figure (2): show the measurement of P

Determination of the consumption of nitrogen and phosphate substrate is also a useful method for estimation of the process of biodegradation of Hydrocarbon. Since microorganisms consume nitrogen and phosphate as a nutrition components during their growth as it is one of the essential components of their cells and the only source of nitrogen in the culture media was KH_2PO_4 and for phosphate K_2HPO_4, the performance of the microorganisms to accelerate the biodegradable.

The Measurement of oil content The experiments to measure the oil content after decompose biologically by bacteria. Where the proportion of oil prior to treatment 26.8 mg / l, as is evident in the table after the results showed a clear reduction oil content and within 24 days. This apparent decrease due to the effectiveness of the consumption of the key elements of bacteria as a food source and energy. The percentage of oil consumption 4.7.The consortium affectivity biodegraded the waste hydrocarbon in the water, Stimulated biodegradation of crude oil is at present being encouraged because it ensures rapid remediation of oil polluted ecosystems. The presence of bacteria in the water assisted to accelerate the existence the essential components like N, P and Carbon source classified the important components the Microorganism to continue. The microorganisms capable of utilizing oil and oil products as a sole source of carbon and energy occur practically everywhere in air, water and soil (Zulfiqar and Safia, 2012).

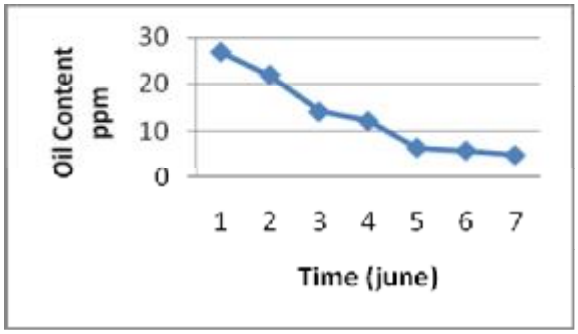

Figure (3): the oil content Concentration through bioremediation process.

The analytical of BOD and COD: The values of BOD generally lower than that for COD. The reasons are that many organic compounds which are oxidized by $K_2Cr_2O_7$ are not biochemically oxidizable and

certain inorganic ions such as sulfides (S^{2-}), thiosulfates ($S_2O_3^{2-}$), sulfites (SO_3^{2-}), nitrites (NO_3^-) and ferrous ion (Fe^{2+}) are oxidized by $K_2Cr_2O_7$, thus accounting for inorganic COD, which is not detected by the BOD test (Ramalho, 1977).

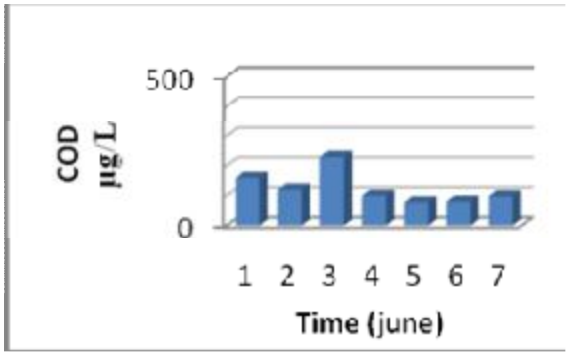

Figure (4): The COD Concentration through bioremediation process.

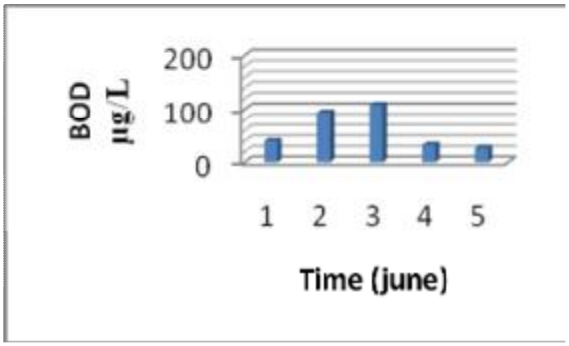

Figure (5): The BOD Concentration through bioremediation process.

Phytoremediation to Petroleum Hydrocarbons: PhytoremediationIs dynamic process different types of plants used to analyze and dismantle hydrocarbon contaminants in soil and water. Figure above shows a clear reduction in the content of hydrocarbon compounds by absorption of these plants to hydrocarbons dysfunctional. The main reason to decline the Hydrocarbon concentration by plant due to the negative charges on the cell wall of the plant *Ceratophyllum* which combine with cautions of hydrocarbons dismantled as a result of this union gets an increase in plant uptake of hydrocarbon compounds, And thus gets an increase in the low hydrocarbon content in the water (Daryabeigi *et al.,* 2009).

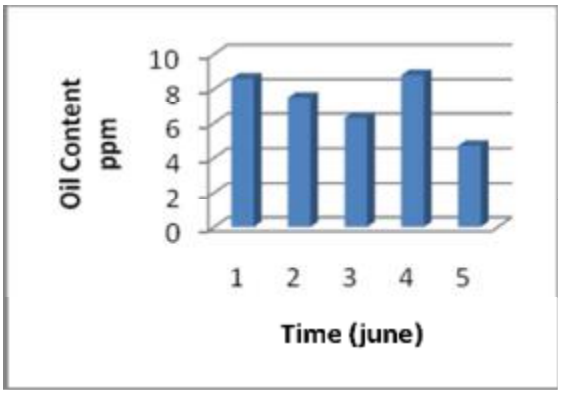

Figure (6): the oil content Concentration through Phytoremediation process.

Conclusion

The result of the study showed that the bioremediation process of waste hydrocarbon in the water during 40 days, and gave the best result after 25 days of bioaugmentation and 15 days of phytoremediation, also this research showed that the ceratophyllum plant 8.8 ppm appear the best efficient absorption of waste hydrocarbon from the potmogen plant 5.7 ppm and decrease the oil content in the water contaminated by waste hydrocarbon from 26.8 ppm to 4.5 ppm. So, we recommended to used this plant in bioremediation process to absorption of waste hydrocarbon and other heavy metals.

References

Abdulrahim, A.A. and Gaber, M.A., 2010. Biological Treatment of Hydrocarbon Contaminants: Petroleum Hydrocarbon uptake by Pseudomonas alkanolytica. Eng. Sci., 21(1): 39-53.

AOAC, Association of Official Analytical Chemists, 1980. Official Methods of Analysis. 13th ed., Washington, D.C.

APHA, American Public Health Association, 1998. Standard Methods for the examination of water and wait water, 20th Edition. A.P.H.A., 1015 Fifteenth Street, Nw. Washington, Dc.

Chikere, C.B., Okpokwasili, G.C. and Chikere, B.O., 2009. Bacterial diversity in a tropical crude oil-polluted soil undergoing bioremediation. African J. Biotechnol., 8(11): 2535-2540.

Cortez, H., Pingarrón J., Muñoz, J.A., Ballester, A., Blázquez, M.L., González, F., García, C. and

Coto, O., 2010. Bioremediation of soils contaminated with metallic-ferrous mining wastes trends in bioremediation and Phytoremediation. 283-299.

Daryabeigi, A., Gholamreza N. B., Nasser M., 2009. Phytoremediation of total petroleum hydrocarbons (TPHs) using plant species in Iran. Doi: 10.3906/ tar- 0903-2.

Dilsad, O., Belma, A. and Gokcen Y.C., 2011. Investigation of Metabolite Productions and Degradation of Hazardous Organic Pollutants by Pseudomonas spp. J. Appl. Biol. Sci., 5(2): 9-14.

NJOKU, K.L., Aknola, M.O. and Oboh, B.O., 2009. Phytoremediation of crude oil contaminated soil. The effect of glycine max on the physic-chemistry and crude oil contents soil. Nature and Science 7(10).

Płaza, G. A., Łukasik K., Wypych J., Nałęcz-Jawecki G., Berry C., Brigmon R.L., 2008. Biodegradation of crude oil and distillation Products by biosurfactant-broducing bacteria. Polish J. Environ. Stud., 17(1): 87-94.

Ramalho, R.S., 1977. Introduction to Wastewater Treatment Process. A Subsidiary of Harcourt Brace Jovanovich, Publishers.

Rengathavasi, T., Singaram J. and Ibrahim M.B., 2011. Application of bio-surfactant produced from peanut oil cake by Lactobacillus delbrueckii in biodegradation of crude oil. Bio resou. Technol., 102: 3366–3372.

Sunday, A.A., Olukayode, O.A., Matthew, O.I., Dupe, O.D. and Joy, O., 2008. Growth and bio-surfactant synthesis by Nigerian hydrocarbon-degrading estuarine bacteria Int. J. Trop. Biol., 56 (4): 1603-1611.

WQMM, Water Quality Monitoring Manual, 2008. Environmental management bureau department of environment and natural resources.

Xueqing, Z., Albert D.V., Makram T.S., and Kenneth, L., 2004. Guidelines for the bioremediation of oil-contaminated salt marshes. EPA/600/R-04/074.

Zulfiqar A.M. and Safia A., 2012. Degradation of petroleum hydrocarbons by oil field isolated bacterial consortium. African J. Biotechnol., 11(3), pp. 650-658.