Journal of
Bioremediation & Biodegradation

Xenia and Refugio, J Bioremed Biodeg 2016, 7:2
10.4172/2155-6199.1000340

Research Article Open Acces

Microorganisms Metabolism during Bioremediation of Oil Contaminated Soils

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Abstract

The development of some industrial processes, such as extraction, reýning and oil transportation has been the cause of environmental degradation caused by oil spills and their extraction processes involved. In order to reduce these contaminants, among others, physicochemical technologies have been applied, which haven't solved the contamination problem because in many of these processes, new toxic compounds are generated. Technologies based in the use of microorganisms, plants and other biological species are called bioremediation. This is an alternative to the physical and chemical processes of treatment that, although slower in response, are more sustainable. Therefore, in this review, bioremediation technologies to treat oil contaminated soils are analyzed as a convenient alternative for the restoration of impacted soils, against progressive deterioration of environmental quality. Additionally, the microorganisms as well as the required conditions for which bioremediation is ar2Tw Tin response, are

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Received January 27, 2016; **Accepted** March 04, 2016; **Published** March 11, 2016

Citation: Xenia ME, Refugio RV (2016) Microorganisms Metabolism during Bioremediation of Oil Contaminated Soils. J Bioremed Biodeg 7: 340. doi: 10.4172/2155-6199.1000340

carried out by bacteria, fungi, protozoa and other organisms (Figure 1). e process of biodegradation includes the following reactions: oxidation-reduction, adsorption processes and ion exchange, as well as chelation reactions that result in metal buildup. Microbial biodegradability allows the transformation of hydrocarbons of complex structure into a more simple chemical structure [8]. When the transformation is simple, it is called "primary", when complete, "mineralization", in the latter, hydrocarbon is decomposed into inorganic compounds and/or cellular constituents [9,10]. e acceleration in hydrocarbon biodegradation may be carried out by native microorganisms or bio-augmentation, with appropriate nutritional and environmental conditions [11].

Hydrocarbon biodegradative microorganisms

Bacteria: Among the most studied bacteria in this process are , *A* , , and *M* , these degrade aliphatic and aromatic hydrocarbons, using them as the only source of carbon and energy. Aerobic degradation is carried out by dioxygenases enzymes that use oxygen during the degradation process (Figure 2). Microorganisms rst oxidize the carbon molecule through a complex multi-enzymatic (oxygenase type enzymes) that incorporate an oxygen molecule. is is how a hydrocarbon with an alcohol group molecule (a more reactive one) is obtained. Other enzymes oxidize the alcohol group to an aldehyde group and nally to a carboxylic acid. Because of this, a molecule, similar to a fatty acid, is obtained and it may be degraded to an acetyl-CoA by beta oxidation. is process of oxidation can occur in non-terminal carbons, giving place to two fatty acids that are processed by beta oxidation [12].

Biodegradation can also be done in the absence of oxygen, as it happens in the deepest hydrocarbon sediments or reservoirs from which anaerobic bacteria has been isolated [13,14]. Bacteria use nitrates, sulfates and iron as electron acceptors for their metabolism [15]. Example of it is the *A*

hydrocarbons. Marine algae (cyanobacteria, green algae and diatoms) are capable of metabolizing naphtalene into a series of metabolites [37]. e metabolic route of decomposition of hydrocarbons of the

is highly recommended to perform treatability tests in the laboratory, pilot level, to de ne the most appropriate treatment conditions, decide the type of process to be applied and reduce time without increasing costs for its application on a large scale.

When applying a bioremediation system, it is important to consider using the organisms (fungi, bacteria, yeast and plants) that have survived the ground contamination; because of their adaptability in contaminated ground, they are crucial candidates as bioremediators. Using their tolerance, defense and biodegradation mechanisms is a fast and e cient process that does not generate pollutants, is low in cost, and allows to restore hydrocarbon contaminated soils.

Acknowledgement

The authors acknowledge the ýnancial support of provided by CONACyT to Xenia Mena Espino (Cátedra: 1665).

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