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Ex-situ Bioremediation Techniques Used for Assessment of Environmental Pollution

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Abstract

Pollution has increased in recent decades due to increased human activity in energy storage, unsafe agricultural practices, and rapid industrialization. Pollutions that cause environmental and health problems due to toxicity include heavy metals, nuclear waste, pesticides, greenhouse gases, and hydrocarbons. Restoration of contaminated areas (bioremediation) using microbial processes has proven to be effective and reliable due to its environmentally friendly properties. Bioremediation can be performed either out of habitat or out of habitat, depending on several factors, including but not limited to cost, site characteristics, type and concentration of contaminants. In general, out-of-range techniques are clearly more expensive than field techniques as a result of the additional costs associated with drilling. However, the cost of installing on-site equipment and the inability to effectively visualize and control the underground of a contaminated site are major concerns when performing on-site bioremediation. Therefore, choosing the right bioremediation technique to effectively reduce contaminant levels to a benign state is critical to the success of the bioremediation project. The aim of this review is to provide a comprehensive knowledge on the two major bioremediation techniques with regards to Assessment of Environmental Pollution.

Keywords: Pollution; Nuclear waste; Greenhouse gases; Bioremediation techniques

Introduction

Over the last two decades, there have been recent advances in bioremediation technology with the ultimate goal of effectively recovering a polluted environment at a very low cost with an environmentally friendly approach. Researchers have developed and modeled a variety of biological repair techniques. However, due to the nature and / or nature of the pollutants, there is no single biological restoration technique that acts as a "silver bullet" to restore a polluted environment. Native (natural) microorganisms found in contaminated environments are the key to solving most of the challenges associated with pollutant biodegradation and bioremediation; provided that environmental conditions are suitable for their growth and metabolism will be [1] environmental consideration and cost savings are one of the main advantages of bioremediation over chemical and physical repair methods. So far, some good definitions of bioremediation have been presented, with particular emphasis on one of the processes (decomposition). Nevertheless, in some cases, the term biodegradation is used interchangeably with bioremediation. The former is a term that applies to the latter process. In this overview, bioremediation is defined as the process of reducing (degrading, detoxifying, mineralizing, or converting) the concentration of pollutants to a benign state, depending on biological mechanisms. The process of removing contaminants depends primarily on the type of contaminant. This includes pesticides, chlorine compounds, dyes, greenhouse gases, heavy metals, hydrocarbons, nuclear waste, plastics and waste water. Apparently, bioremediation techniques can be categorized as out of habitat or out of habitat, depending on where they are applied. The type of pollutant, the depth and level of pollution, the type of environment, location, cost, and environmental policy are some of the selection criteria considered when choosing a bioremediation technique [2].

In addition to selection criteria, performance criteria (oxygen and nutrient concentrations, temperature, pH, and other abiotic factors) that determine the success of the bioremediation process are also considered prior to the bioremediation project. Although bioremediation techniques vary, most bioremediation studies focus on hydrocarbons due to the general contamination of soil and groundwater with this particular type of pollutant [3, 4]. In addition, when repairing sites contaminated with non-hydrocarbon contaminants, other repair techniques that may be more economical and efficient to use for repair may be considered. In addition, given the nature of activities that lead to pollution by crude oil, it may be possible to easily prevent and control environmental pollution by contaminants other than hydrocarbons. In addition, reliance on petroleum and other related products as a major source of energy appears to contribute to increased pollution by this class of pollutants [5, 6].

Ex-situ bioremediation techniques

Ex-situ bioremediation techniques such as biopile, windrows, bioreactor, and land farming are used for excavating pollutants from polluted sites and subsequently transporting them to another site for treatment.

Biopile

Bioremediation via biopile enhances bioremediation by stacking excavated contaminated soil on the ground, followed by adding nutrients and, in some cases, aeration, primarily by increasing microbial activity. The components of this technology are aeration, irrigation, nutrient and leachate collection systems, and treatment beds. The use of this particular out-of-habitation technique includes cost-effectiveness that enables effective biodegradation under conditions where nutrients, temperature, and aeration are adequately controlled volatilization of low molecular weight contaminants (LMWs). It is being increasingly

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considered because of its constructive properties. It can also be effectively used to disinfect contaminated extreme environments such as very cold areas [7]. The flexibility of the biopile allows the heating system to be incorporated into the biopile design to increase microbial activity and pollutant availability and accelerate biodegradation, thus reducing repair time [5, 8].

Biopile systems save space compared to other off-site on-site bioremediation technologies such as land management, robust engineering, maintenance and operating costs, but especially due to lack of power supply in remote areas. Air can be evenly distributed to contaminated landfills via an air pump. Some of the biopile limits. In addition, overheating the air can dry the soil undergoing bioremediation, reduce microbial activity, and promote volatilization rather than biodegradation [9].

Windrows

As one of ex situ bioremediation techniques, windrows rely on periodic turning of piled polluted soil to enhance bioremediation by increasing degradation activities of indigenous and/or transient hydrocarbonoclastic bacteria present in polluted soil. The periodic turning of polluted soil, together with addition of water bring about increase in aeration, uniform distribution of pollutants, nutrients and microbial degradative activities, thus speeding up the rate of bioremediation, which can be accomplished through assimilation, biotransformation and mineralization [10]. Windrow treatment when compared to biopile treatment, showed higher rate of hydrocarbon removal; however, the higher efficiency of the windrow towards hydrocarbon removal was as a result of the soil type, which was reported to be more friable [11]. Nevertheless, due to periodic turning associated with windrow treatment, it may not be the best option to adopt in remediating soil polluted with toxic volatiles. The use of windrow treatment has been implicated in CH4 (greenhouse gas) release due to development of anaerobic zone within piled polluted soil, which usually occurs following reduced aeration [12].

Bioreactor

A bioreactor, as the name implies, is a container in which raw materials are converted into a particular product after a series of biological reactions. There are several bioreactor operating modes, including batch, fed-batch, sequence batch, continuous and multi-step. The choice of operating mode depends primarily on the market economy and investment costs. Bioreactor conditions support natural cellular processes by mimicking and maintaining the natural environment to create optimal growth conditions. Contaminated samples can be fed to the bioreactor as a dry material or slurry. In any case, the use of bioreactors when treating contaminated soil has several advantages over other out-of-range bioremediation techniques. Excellent control of bioprocess parameters (temperature, pH, agitation and aeration rate, and substrate and inoculum concentration) is one of the main advantages of bioreactor-based bioremediation. The ability to control and manipulate process parameters in a bioreactor means that the biological response within the bioreactor can be improved and bioremediation time can be effectively reduced. Importantly, one of the limiting factors in the bioremediation process is controlled bioaugmentation, addition of nutrients, increased bioavailability of pollutants, and mass transfer (contact between pollutants and microorganisms). It can be effectively established in bioreactors, further improving bioreactor-based bioremediation efficient in addition, it can be used to treat soil and water contaminated with volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene and xylene (BTEX) [13].

Land farming

Land management is one of the simplest bioremediation techniques due to its low cost and reduced equipment required for operation. In most cases it is considered an out-of-range bioremediation, but in some cases it is considered an out-of-range bioremediation technique. This discussion is due to the location of treatment. The depth of pollutants plays an important role in the ability of land management to be carried out of habitat or out of habitat. One thing that is common in agriculture is that contaminated soil is usually excavated and / or cultivated, but the treatment site seems to determine the type of bioremediation. If the excavated contaminated soil is to be treated on-site, it can be treated on the spot. Otherwise, it is out of habitat because it has much in common with other out-of-range bioremediation techniques. When the pollutant height is 1.7 m, it is reported that the pollutant must be transported to the surface in order to effectively enhance bioremediation [14]. In general, excavated contaminated soil is carefully applied to the solid support layer above the soil surface, allowing aerobic biodegradation of contaminants by endemic microorganisms [15-17].

Conclusion

One of the main advantages of using these type of bioremediation techniques is that they do not require a comprehensive preliminary assessment of contaminated areas prior to repair. This reduces the preparation stage, reduces complexity, and reduces costs. Due to the drilling process associated with this bioremediation, the non-uniformity of pollutants due to depth, non-uniform concentration, distribution changes some process parameters (temperature, pH, mixing) of out-of-range bioremediation enhancement techniques. It can be easily contained by doing. These techniques enable the modification of biological, chemical and physicochemical conditions and parameters required for effective and efficient bioremediation. Importantly, when contaminated soil is excavated, it can reduce the significant impact of soil porosity, which determines the transport process during restoration.

Conflicts of interest

The authors have no conflicts of interest.

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