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Bioremediation Technology for Cleaning Environment: A Review

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Abstract: *Bioremediation gives a more suitable alternative on account that it's far less pricey and can be used to gain the selective remediation of goal contaminants with out incurring widespread collateral damage to existing fauna and plants. Bioremediation is the handiest control device to manipulate the polluted environment and recover contaminated soil. The dangerous wastes generated from the chemical processes/operations are being treated the usage of physico-chemical and organic strategies by means of the respective industries to fulfill the prescribed popular as in step with the Environmental Protection Act, 1986. The wastes handled by the respective industries are amassed at Common Effluent Treatment Plant, earlier than discharge into the environment. After the treatment of accumulated waste at Common Effluent Treatment Plant, the stable and dealt with effluents are segregated and disposed of into the soil- water environment. In spite of the prevailing remedy generation, the organic pollution are discovered persisting inside the soil-water environment above their proper stage.*

Keywords- Petroleum hydrocarbon, agricultural soils, bioremediation, animal manure

I. INTRODUCTION

In the last few a long time the industrial revolution has led to an first rate launch of hazardous compounds into the environment, endangering the ecological stability of our planet. The launch of hydrocarbons whether accidentally or because of human hobby is a high cause of water and soil pollution. Management of pollution is achieved by largely physico-chemical techniques like incineration, adsorption or extraction [1]. However, those techniques are usually tough to hire or cannot be scaled up universally due to their prohibitive expenses and additionally seldom bring about the secondary pollutants of the surroundings. Benzene is a major mono-fragrant hydrocarbon produced by many manufacturing procedures and present in petroleum based totally fuels. It is a constituent of motor fuels; a solvent for fats, waxes, resins, oils, inks, paints, plastics, and rubber; used inside the extraction of oils from seeds and nuts; and in photogravure printing [2]. It is also used in the manufacture of detergents, explosives, prescribed drugs, and dyestuffs [3]. Benzene is a common industrial pollutant and a thing of fuel. The US Environmental Protection Agency has categorized benzene as a Group A human carcinogen. It became selected as a excessive precedence candidate for attention below Proposition sixty five based totally on choice by using a group of professionals in reproductive toxicity combined with use, manufacturing and publicity records [4]. Benzene was additionally one of 14 high priority dealers selected via a Delphi committee of experts organized by using OEHHA to prioritize candidate DARTs. Benzene is a radiomimetic and its exposure may additionally lead steadily to aplastic anaemia, leukaemia and multiple myeloma [5]. Long-time period exposure to benzene has the ability to cause continual fitness consequences which includes imperative frightened machine (CNS) damages, cardiac outcomes, and lung cancers. The big use of benzene has led to presence in groundwater because of leaks in underground storage tanks and pipelines, wrong waste disposal practices, inadvertent spills and leaching from landfills [6].

Conventional strategies like air sparging, air stripping, adsorption and vapour phase extraction are typically used for the removal of benzene. However, these techniques are costly and might lead to incomplete decomposition of contaminants. Bioremediation seems to be an economical, strength efficient and environmentally sound method. It is defined as a technology that can transform contaminants into less dangerous paperwork by microorganisms and their produced substances. The best benefit of bioremediation is environmental friendliness [7]

The harmful effects of oil in different environments, has led to the need to develop simple adoptable remediation techniques for petroleum products polluted sites using different simple and affordable methods, which may include physical, chemical and biological processes (Okoh, 2006). Many industrial scale soil and water remediation of process as leading to eventual removal of hydrocarbon from the environment have been extensively documented. The physical methods of incineration or dig and dump in secure landfills (USEPA, 2001; ITOPF, 2006), as well as chemical method which involves the use of thermal and solvent treatment have been extensively reviewed (Rosenberg et al., 1992; Lee and DeMora, 1999; Cohen et al., 2001). These methods are however expensive when contaminated areas are large (Okoh, 2006) and it may pose possible collateral destruction of the site material or its indigenous flora and fauna (Timmis and Pieper, 1999; Pye and Patrick, 1983). Bioremediation processes that employ the use of microorganisms to degrade environmental contaminants (Atlas and Cerniglia, 1995; McClay et al., 2000; Boopathy, 2001; Bidwell et al., 2002), have also proved effective and could be used to accomplish both effective detoxification and volume reduction. The advantage of this remediation process over physicochemical remediation method is that it is believed to be non invasive and relatively cost effective (April et al., 2000)

II. RELATED WORK

Bioremediation processes could be enhanced either by addition of commercial microbe cultures (bio-augmentation) (Chhatre et al., 1996; Komukai-Nakamura et al., 1996; Venkateswanan and Harayama, 1995) or by nutrient enrichment (bio-stimulation) of the natural microbial population (Boopathy, 2001; Bidwell et al., 2002).

Several laboratory and field investigation have indicated that addition of nutrients provide certain advantages over addition of microbes, except in cases where pollutant toxicity and appropriate microorganisms are lacking (Lee and Levy, 1991; Okolo et al., 2005). Many published reports have shown that addition of microbes did not significantly enhance the rate of oil biodegradation over that achieved by nutrient enrichment (Fayad et al., 1992; Venosa et al., 1992). This for example was experienced in Exxon Valdez as reported by van Hamme et al. (2003) that bioaugmentation was ineffective in petroleum degradation process.

Numerous laboratory studies on the use of fertilizer to enhance oil biodegradation by naturally occurring microbes have concluded that fertilizer use has the potential as a treatment technique for removing hydrocarbon in an impacted area (Lee and Levy, 1991; Pelletier et al., 2004). However, several components of fertilizer are toxic to humans and other organisms even at certain concentration (Lee and Levi, 1991). Secondly nutrient concentration can inhibit the bio-degradation activity (Challaina et al., 2006). Several authors have specifically reported the negative effects of a high NPK level on the biodegradation of hydrocarbons (Oudot et al., 1998; Chaineau et al., 2005). According to Hoff (1991), microbes preferred to utilize organic components of the fertilizer instead of the oil. Okolo et al. (2005) investigated the impact of addition of poultry manure alone to enhance bioremediation process in crude oil contaminated soil, while Ibekwe et al. (2006) studied the effect of organic nutrient on microbial utilization of hydrocarbons on crude oil contaminated soil. Ewulo (2005), studied the effect of poultry dung and cattle manure on chemical properties of clay and sandy clay loam soil, exposed to pollutants while Ogboghodo et al. (2004) established the effects of application of poultry manure to crude oil polluted soils on maize (Zea mays) growth and soil properties. Animal manure has been shown to be nutritionally rich in energy, protein, mineral and vitamins (Abulude at al., 2003), which can help in the improvement of soil properties, especially farmlands, without any potential health risk on living biota

III. MATERIALS AND METHODS

Micro-organisms are now known to be the principal agents, which can clean and modify the complex lipophilic organic molecules, once considered recalcitrant, to simple water soluble products. They first attack these organic chemicals by the enzymatic apparatus acquired during the course of enrichment, when they are exposed to these specific or structurally related compounds. Presence of these contaminants in the environment either induces or depresses the enzymatic function of microorganisms. This capability largely depends upon the selective microbial community as well as on the structural and functional groups of toxic compounds. These water soluble intermediates are usually attacked by primary or secondary groups of organisms to form inorganic end products, resulting in complete biodegradation. Bioremediation is the use of living organisms, primarily microorganisms, to degrade the environmental contaminants into less toxic forms. It uses naturally occurring bacteria and fungi or plants to degrade or detoxify substances hazardous to human health and/or the environment. The micro-organisms may be indigenous to a contaminated area or they may be isolated from elsewhere and brought to the contaminated site. Contaminated compounds are transferred by living organisms through reactions that take place as a part of their metabolic processes. Biodegradation of a compound is often a result of the actions of multiple organisms. When microorganisms are imported to a contaminated site to enhance degradation, the process is called as "Bio-augmentation". The microorganisms with the genetic capacity to transform compounds of interest must be present in contaminant metabolism to occur in a bioremediation process. In certain cases, the addition of organisms acclimated to specific contaminants, or bioaugmentation, may decrease the duration of lag phases. The ability to effectively bio-augment bioremediation system is a function of the process used. Bioremediation is an option that offers the possibility to destroy or render harmless various contaminants using natural biological activity (Gupta, 2003).

A. Bioremediation Organisms

Microorganisms that carry out biodegradation in many different environments are identified as active members of microbial consortiums. These microorganisms include: Acinethobacter, Actinobacter, Acaligenes, Arthrobacter, Bacillins, Berijerinckia, Flavobacterium, Methylosinus, Mycrobacterium, Mycococcus, Nitrosomonas, Nocardia, Penicillium, Phanerochaete, Pseudomonas, Rhizoctomia, Serratio, Trametes and Xanthofacter.

Microorganisms individually cannot mineralize most hazardous compounds. Complete mineralization results in a sequential degradation by a consortium of microorganisms and involves synergism and co metabolism actions. Natural communities of microorganisms in various habitats have an amazing physiological versatility, they are able to metabolize and often mineralize an enormous number of organic molecules. Certain communities of bacteria and fungi metabolize a multitude molecules that can be degraded is not known but thousands are known to be destroyed as a result of microbial activity in one environment or another. Most bioremediation systems are run under aerobic conditions, but running a system under anaerobic conditions (Colberg and Young, 1995) may permit microbial organisms to degrade otherwise recalcitrant molecules.

B. Bioremediation Research Studies Using Designed and Developed Laboratory Bioreactors

Bioremediation of pesticide in surface soil treatment unit using microbial consortia The manufacturing and use of pesticides has been rising tremendously in India. The waste generated by the pesticide industry has become an environmental problem due to the present insufficient and ineffective waste treatment technology involving physico-chemical and biological treatment. The available data indicates that pesticide residues remain in surface soil, leading to toxicity in the soil-water environment. The recent advances in bioremediation technology using microbial consortium has been found effective for treatment of pesticides in soil. In the present study, a Surface Soil Treatment Unit has been designed wherein bioremediation of commonly used pesticides namely chlorpyrifos, cypermethrin, fenvalerate, and trichlopyr butoxyethyl ester at varying concentration viz. 25, 50 and 100 mg/kg have been carried out using cow-dung microbial consortia under simulated environmental conditions. The bioremediation conditions have been monitored and maintained during the study. The investigation has been extended till the parent compound was converted into intermediates and/or less harmful compounds. These then will further mineralize, from part of the microbial food chain and/or become integrated into the humic fractions. The results presented here highlight the potential of cow-dung slurry consortia for bioremediation of soil contaminated with pesticides in surface soil treatment unit (Geetha and Fulekar, 2008).

C. Bioremediation of pesticides using scale up process bioreactors

To assess the bioremediation potential of Pseudomonas aeruginosa (NCIM, 2074) by improving its adaptability to increasing concentration of chlorpyrifos using scale up process. Pseudomonas aeruginosa isolate NCIM 2074 was adapted by subjecting to varying concentrations of chlorpyrifos, i.e. 10, 20, 50, 75 and 100 mg/l in incubator shaker at 37°C and 150 rpm. An initial 10 mg/l concentration of chlorpyrifos was supplied in minimal salt medium (MSM) under controlled environmental conditions for 14 days. The culture was subsequently scaled up to higher concentrations of chlorpyrifos by transferring one milliliter from the medium with 10mg/L to 25 mg/l of the compound. After every 14 days this process was repeated, each time using medium with higher chlorpyrifos concentration. The entire scale up process continued for a period of 70 days. Pseudomonas aeruginosa (NCIM 2074) was adapted to increasing chlorpyrifos up to 50 mg/l, but 75 and 100 mg/l was inhibitory to the organism. The biodegradation of chlorpyrifos, as assessed by GC-MS, showed that chlorpyrifos at 10, 25, 50 mg/l degraded completely over a period of 1, 5 and 7 days, respectively. The intermediate 3, 5, 6 trichloro-2-pyridion, 2, 4-bis (1, 1 dimethyiethyl) phenol and 1, 2 zenedicarboxylic acid persisted during bioremediation, but in the long run these convert to CO2, biomass and nutrients.

IV. CONCLUSION

The study has recognized a unique strategy for biodegradation of one of the most strong and widely accumulated pollutant, benzene. The use of simple and easily available waste, cow-dung harbor a range of microbes that show a great potential to degrade benzene. These bacteria in isolation or as a consortium utilize and multiply in presence of high benzene concentrations.

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