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Bioremediation of polluted soils: A review

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Abstract
Bioremediation is defined as the use of biological processes to degrade, break down, transform or essentially remove pollutants or contaminants of the natural environments such as soil, water etc Bioremediation is brought about by the action of microorganisms suc as bacteria, fungi etc. Bioremediation can also be brought about by plants. Microorganisms are capable of using these pollutants as source of carbon and energy. Microorganisms are capable of degradation of complex (toxic) pollutants to simple (nontoxic) forms. This paper summmarises the processes of bioremediation of soils by microorganisms and their role in the abatement of soil pollution. The effect of soil conditions on the rate of biodegradation is also addressed.

Keywords: bioremediation, bioaugmentation, biostimulation, biodegradation

Introduction

Soil is an important part of the environment, which supports all te living organisms on the planet earth. Soil has been subject to pollution by indiscriminate release of municipal wastes, industrial effluents, pesticides, plastics, petroleum wastes etc. The pollution is mainly due to the complex organic compounds (xenobiotics), heavy metals such as Mercury, Lead, Arsenic, Cadmium, Zinc etc. (Paroda R.S, 1999) [1] These chemical substances accumulate in the soils and cannot be degraded easily. This has an adverse effect on the human health, animal health, plant growth and also on the beneficial microflora of the soil. It may also cause ground water pollution by seepage. Therefore, it is very important to overcome the soil pollution and maintain soil health. In this direction, bioremediation is an important strategy to reduce soil pollution. Bioremediation employs microorganisms such as bacteria, fungi and plants in the degradation of complex organic pollutants. (M. Vidli, 2001) Bioremediation is brought by microorganisms by enzymatic action on the pollutants and convert them into non-toxic forms. There are several factors which effect the process of bioremediation of polluted soils. They include-Tempetrature, pH, Aeration, organic matter, soil texture, oxidation-reduction potential etc. Bioremediation can take place if the conditions are favourable for the growth of microorganisms (M. Dua *et al.*, 2002) [3]. Application of bioremediation often involves manipulation of environmental factors to allow microbial growth and degradation effectively. The process of bioremediation is very slow process, Because the soil bacteria and fungi cannot readily degrade the organic pollutants (Yong R; Mulligan C; 2004) The disposal of plastic wastes into the environment is posing an ever-increasing threat. Plasics are typically organic polymers of high molecular weight, that are derived from petrochemicals. In this context biodegradation of plastics by microorganisms such as bacteria and fungi can be considered as an useful for bioremediation. ex: -Bacillus subtilis, Bacillus amylolyticus, Aspergillus sps, Penicillium sps. (Anonymous, 1999) [4].

Bioremediation

Bioremediation fefers to the process of using microorganisms to remove the toxic pollutants from the soil, water etc. The microorganisms serve as the agents of bioremediation. Microorganisms such as bacteria, fungietc. bring about the removal of pollutants from soils. The microorganisms degrade the complex organic complex organic compounds to simple compounds, which are non –toxic. (US Microbics, 2003) [7] Hence microorganisms help in the reclammmation of polluted soils. The pollution is due to pesticides, industrial effluents etc. Some plants are also capable of removing pollutants from soils. This is referred to as Phytoremediation. (Jogland, S.N. 1995) [10] There are several factors which effect the process of bioremediation, which include-Temperature, pH, aeration, organic matter, soil texture, oxidation-reduction-potential etc. Bioremediation can be effective only when environmental conditions permit microbial growth and activity. (Alexander. M. 1981. Science. 211:132-138) [8]

Types of bioremediation

The process of bioremediation of polluted soilscan be brought in two ways-In situ and ex situ bioremediation.

In situ bioremediation

In situ bioremediation involves a direct approach for the microbial degradation of Xenobiotics at the sites of pollution especially especially soil. Addition of nutrients i.e organic matter at the site promotes microbial growth. When the microorganisms are exposed to xenobiotics (pollutants), they develop metabolic abilty to degrade them. In situ bioremediation has been successfully applied for cleanup of oil spillages, heavy metal pollution etc. (Mueller, J.G *et al*, 1996) [9] Biostimulation Biodegradation of pollutants in soils is limited by many factors including nutrients, pH, temperature, moisture, oxygen, soil properties and contaminant presence and its concentration. Biostimulation involves the modification of the environment to stimulate existing microorganisms such as bacteria and fungi,
which can degrade the pollutants. This is done by addition of

various forms of limiting nutrients and electron acceptors, such as organic matter, which otherwise is present in lower quantities to constrain microbial activity. This will also increase the microbial population available for bioremediation. (Atagena 2008) [5]

Bioaugmentation It is possible to increase biodegradation by employing consortium of microorganisms. This is accomplished by addition of microbial cultures to the site of biodegradation. By increasing the population of microorganisms, the biodegradation process can be enhanced. On the other hand, the use of genetically engineered bacteria are also being employed for biodegradation of organic pollutants, especially for clearing oil spills. The bacteria are genetically modified in such a way that they can metabolise a wide array of hydrocarbons such as olefins, parafins etc. avery good example is the of genetically engineered Pseudomonas spp. (Leahy J.G and Cowell RR, 1990) [6]

Conclusion

Bioremediation, by using microorganisms has been an effective tool in reducing pollution of soils caused by oil spills, industrial effluents, pesticidepollution, plastics. Genetically engineeres microorganisms can be employed for this purpose. It is also important that industries that industries should pretreat the wastes before releasing into the environment such as soil, water bodies etc.

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