

Bioremediation: An Eco- Friendly Remediation Process

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DOI: 10.52984/ijomrc4307

Abstract

Bioremediation is a natural process to remove toxic pollutants from contaminated water, air and soil. This technique is an eco- friendly for environment. Microorganisms, fungi, green plants or their enzymes are used in this process. Bioremediation is divided in two techniques in-situ and ex-situ. In situ bioremediation involves to remediate contaminated materials at the sites or ex situ bioremediation involves to remove contaminants at different sites or areas. Bioventing, bioaugmentation, bioreactors, composting, land farming or bio-stimulation are the examples of bioremediation process. Microorganisms are known as bioindicator or plants are known as hyperaccumulator in bioremediation process. This review paper gives knowledge about bioremediation, principles of bioremediation, types of bioremediation process, advantages and disadvantages of bioremediation.

Keywords: Bioremediation, bioaugmentation, bioventing, bio-stimulation.

Introduction

Due to urbanization and industrialization, numerous pollutant release in environment and cause environment pollution. Increasing pollution is a great concern for mankind. Pollutants release in environment from different industrial processes or other activities. Pollutants degrade the quality of air, water or soil and cause different type of diseases in human. Some toxic heavy metals arising from industrial or agricultural processes in environment and cause heavy metal pollution. Heavy metal pollution is very dangerous for human being. Some heavy metals such as arsenic, mercury, lead, cadmium are more toxic or carcinogenic for humans (Liu et al., 2020). Due to water, air, soil or

heavy metal pollution, the human survival on the earth is going to difficult day by day. There are many physical and chemical methods to remove pollutants from environment but both methods have drawbacks and challenges to manage the contaminants at sites. Bioremediation is an alternative approach to remove pollutants from contaminated air, water or soil. This approach is easy to handle, eco- friendly or cost effective.

Biological remediation or Bioremediation are the use of living organisms such as microorganisms and green plants, to degrade the environmental contaminants into less toxic forms. Many bacteria, fungi or plants degrade the contaminants in air, soil, or water

at contaminated sites. Bioremediation is a natural process to remove contaminants and purify the environment. It is a traditional method and environment friendly. This method is used to clean up the environment without using large or costly equipment.

Principles of Bioremediation:

Bioremediation is the use of living organisms, primarily microorganisms, to degrade the environmental contaminants into non toxic forms (Kour et al., 2022). It uses naturally occurring bacteria and fungi or plants to degrade or remove toxic substances hazardous to human being or the environment. The microorganisms may be aerobic or anaerobic to a contaminated area. Some indigenous microorganism are presented in soil at contaminated site and some microorganism are introduced at contaminated area known as non indigenous microorganisms (Goldstein et al., 1985). The main purpose of bioremediation to clean up the contaminated area without degrading the environment. Green plants also used to remediate the contaminated material and remediation process known as phytoremediation in bioremediation techniques. Biodegradation of pollutants is a result of action of multiple organisms. Bioremediation can be effective only when environmental conditions are suitable for microorganism because the growth or activity of microorganism depends on these conditions (Chang et al., 2013).

Types of bioremediation process:

Bioremediation can be classified as in situ or ex situ bioremediation method to clean-up contaminated sites that are following as-

In situ bioremediation: In this technique, microbes involve to degrade contaminants at the contaminated site (Cao et al., 2020). This remediation is cost effective and easy to handle. It includes many processes such as bioventing, biosparging, biostimulation, bioaugmentation etc.

Bioventing is an in-situ treatment for degrading the organic contaminants with microbes. It is the most

common treatment to detoxify the contaminated sites. It involves delivering nutrients through wells to contaminated soil to stimulate the indigenous bacteria. It provides sufficient amount of oxygen to soil microorganism.

Biosparging involves the injection of air under pressure below the contaminated zone to increase the ground water contamination and enhance the biological degradation activity with natural occurring bacteria.

Bioaugmentation is simple, rapid or cost-effective process. In this treatment, microorganisms are added to polluted sites to degrade toxic pollutants (Mahmoud, 2021). Addition of external microbes to contaminated site augment the resident microbes (Fan, et al 2013).

Biostimulation, this [process/method](#) involves in addition of nutrients (such as nitrogen, ~~potassium, such as nitrogen, potassium, phosphorous or iron~~) [in soil to enhance the activity of resident microbes and increase the rate of remedial process.](#) Biostimulation method is better than bioaugmentation because indigenous or resident microbes are more competitive than the external microbes (Sayed et al., 2021).

Ex situ bioremediation: Ex situ treatment involves in degrading contaminants at different location or site (Ayangbenro and Babalola., 2017). Land farming, biopiles, composting or bioreactors are the examples of bioremediation.

Land farming is an easy method to clean up the contaminants from environment. In land farming treatment, contaminated soil spread over a prepared bed and tilled until contaminants are degraded. In this method, degradation is done by the aerobic microbes.

Composting is a natural process of degrade the agricultural waste or pollutants. It is a biological process to remove contaminants with microorganisms. Microbes degrade the contaminated material and convert into less toxic form (Abdulsalam et al., 2009). Composting is used to degrade the organic waste into non-toxic form and produce manure which is used as a natural fertilizer into agricultural field. Only aerobic microorganism is used in composting.

Biopile is an ex-situ bioremediation process that uses natural processes to transform contaminated waste or pollutants into non-toxic byproducts. Aerobic or anaerobic microbes are used in this process to degrade pollutants.

Bioreactor is also an ex-situ remedial treatment to degrade the contaminated material (soil, sediment, sludge) with biological active environment. Bioreactor are made in cylindrical shape and are composed of stainless steel.

Advantages of bioremediation

- Natural process
- Environment friendly
- Cost effective
- Easy to use
- No handling or transport issue
- Suitable for large areas of soil
- Improve soil quality
- Accepted by public

Reference

1. Mahmoud, G. A.-E. (2021). "Microbial scavenging of heavy metals using bioremediation strategies," in Rhizobiont in bioremediation of hazardous waste. Eds. K. Vivek, P. Ram and K. Manoj (Singapore: Springer), 265–289.
2. Sayed, K., Baloo, L., and Sharma, N. K. (2021). Bioremediation of total petroleum hydrocarbons (TPH) by bioaugmentation and biostimulation in water with floating oil spill containment booms as bioreactor basin. *Int. J. Environ. Res. Public Health* 18 (5), 2226. doi: 10.3390/ijerph18052226
3. Cao, H.-L., Liu, C., Cai, F.-Y., Qiao, X.-X., Dichiara, A. B., Tian, C., et al. (2020). In situ immobilization of ultra-fine Ag NPs onto magnetic Ag@RF@Fe₃O₄ core-satellite nanocomposites for the rapid catalytic reduction of nitrophenols. *Water Res.* 179, 115882. doi: 10.1016/j.watres.2020.115882
4. Ayangbenro, A. S., and Babalola, O. O. (2017). A new strategy for heavy metal polluted environments: a review of microbial biosorbents. *Int. J. Environ. Res. Public Health* 14 (1), 94. doi: 10.3390/ijerph14010094
5. Liu, X., Shi, H., Bai, Z., Zhou, W., Liu, K., Wang, M., et al. (2020). Heavy metal concentrations of soils near the large opencast coal mine pits in China. *Chemosphere* 244, 125360. doi: 10.1016/j.chemosphere.2019.125360

- No need of noisy or large equipment required
- Require low maintenance
- Best alternative of disposal method

Disadvantages of bioremediation

- Time consuming
- Slow process
- Seasonal variations
- Not suitable for high concentration of contaminants
- Only for biodegradable wastes

Conclusion

Bioremediation method is an alternative of conventional or disposal method. Using living organism in remediation is a better approach to detoxify contaminants or environment. It is a natural process and suitable for environment and human beings.

6. Kour, D., Khan, S. S., Kour, H., Kaur, T., Devi, R., Rai, P. K., et al. (2022). Microbemediated bioremediation: current research and future challenges. *J. Appl. Biol. Biotechnol.* 10 (2), 6–24. doi: 10.7324/JABB.2022.10s202
7. Goldstein, R.M., Mallory, L.M., Alexander, M. (1985) Reasons for possible failure of inoculation to enhance biodegradation. *Applied and Environmental Microbiology*, 50, 977-983.
8. Fan, M. Y., Xie, R.J. and Qin, G. (2013). Bioremediation of petroleum-contaminated soil by a combined system of biostimulation-bioaugmentation with yeast. *Environmental Technology*. Volume 35, Issue 4, 2014.
9. Abdulsalam, S. and Omale, A.B. (2009). comparison of Biostimulation and Bioaugmentation Techniques for the Remediation of Used Motor Oil Contaminated Soil. *Brazilian Archives of biology and technology*. Vol.52, n. 3: pp. 747-754.
10. Chang, K.L., Ibrahim, D. and Ibrahim, C.O. (2011). A laboratory scale bioremediation of Tapis crude oil contaminated soil by bioaugmentation of *Acinetobacterbaumannii* T30C. *African Journal of Microbiology Research* Vol. 5(18), pp. 2609-2615, 16 September, 2011 Available online <http://www.academicjournals.org/ajmr>.