EX-SITU BIOREMEDIATION AND ITS APPLICATIONS

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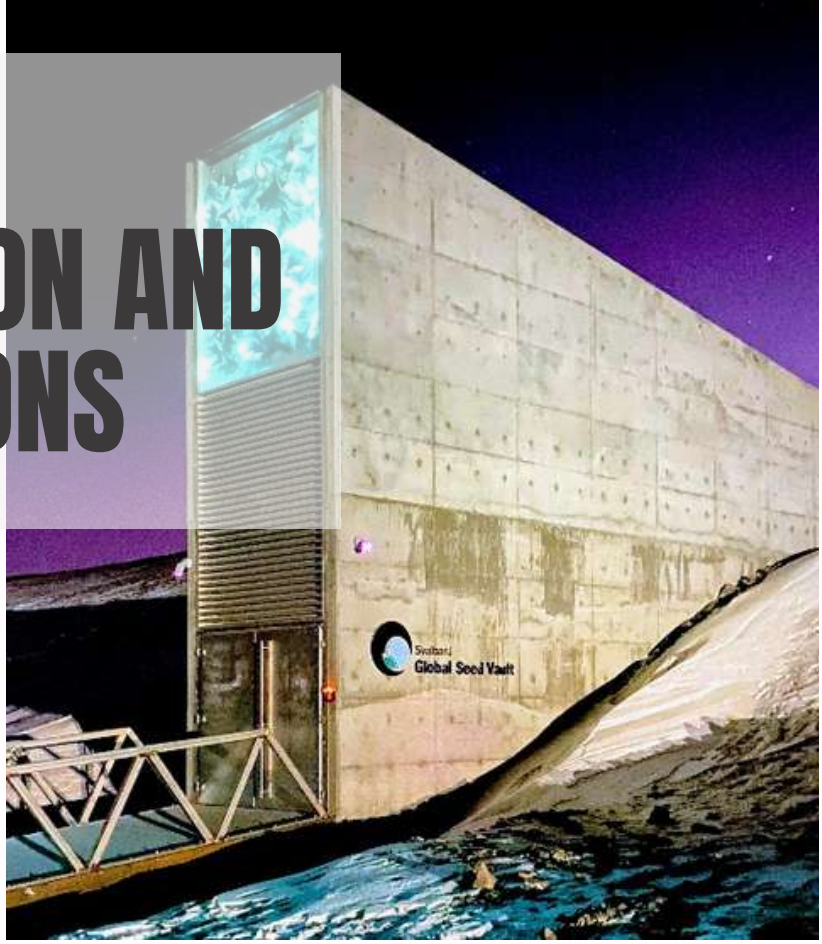

1. Introduction

Bioremediation is the latest development in waste management strategies – the technique involves the use of organisms to eliminate of neutralise pollutants from a contaminated site. Bioremediation means the use of a biological agent to suppress or clear contamination. This is different from remedial measures were contaminated soil or water is removed for chemical or decontamination or incineration or burial in a landfill. Bioremediation is the process, which abates or cleans up contamination. Bioremediation has no use of toxic chemicals.

Microorganisms like bacteria and fungi are the main role player in the process of Bioremediation. Bacteria can easily digest contaminants like chlorinated pesticides or clean oil spills but microorganisms fail to destroy heavy metals like lead and cadmium. In this article further we will discuss about Ex-Situ Bioremediation.

Ex-situ bioremediation: This involves the removal of contaminated soil or water and treating it outside of the contaminated site. This approach is more effective than in situ bioremediation in case where the contaminants are highly concentrated or difficult to access. Ex-situ bioremediation can be further classified into:

- **Composting:** Treating contaminated soil by adding organic matter and microorganisms to promote degradation. It is used to treat organic pollutants, such as petroleum hydrocarbons and contaminated soil. The organic matter is breakdown by microorganisms, resulting in the formation of stable and humus like substances.

Applications of composting

- Agriculture: Composting is widely used in agriculture as a natural fertilizer and soil conditioner. Compost provides essential nutrients to plants, such as nitrogen, phosphorus, and potassium, which can improve soil fertility and increase crop yield. Compost can also improve soil structure and water retention, reducing the need for irrigation and reducing soil erosion.
- Landscaping: Composting is used in landscaping to improve soil quality and promote healthy plant growth. Compost can be used as a soil amendment to improve the texture and nutrient content of soil, making it more suitable for growing plants.

- Compost can also be used as a mulch to supress weeds, retain moisture, and regulate soil temperature.
- Waste Management: Composting is an effective way to reduce organic waste and divert it from landfills. Organic waste, such as food scraps and yard waste, can be composted, reducing the volume of waste and producing a useful product. Composting also reduce greenhouse gas emissions from landfills, as organic waste that decomposes in landfills produces methane, a potent greenhouse gas.
- Erosion Control: Composting is used in erosion control to stabilize soil and prevent soil erosion. Compost can be used as a temporary cover to protect bare soil from wind and rain erosion. Compost can also be used as a permanent cover to establish vegetation and stabilize soil on slopes and embankments.

- Bio-piles: A bio-pile is a bioremediation technology in which soil amendments, formed into compost piles, and enclosed for treatment. The basic bio-pile system enclosed for treatment. To facilitate biodegradation, temperature, nutrients, oxygen, and pH are all controlled. To regulate runoff, evaporation, and volatilization as well as to encourage sun heating, they may be covered with plastic. If soil contains volatile organic compounds (VOCs), the air leaving the soil may be treated to eliminate or destroy the VOCs before they are released into the atmosphere. Following treatment, the excavated material is either disposed of or returned to its original site.

Application of Bio-piles:

- **Petroleum Contamination:** Bio-piling is commonly used to treat petroleum-contaminated soil. Microorganisms, such as bacteria and fungi, are introduced into the soil, where they breakdown the petroleum hydrocarbons into carbon dioxide and water.
- Bio-piling can be an effective way to remediate a petroleum-contaminated soil, especially in cases where the contamination is limited to a small area.
- **Polycyclic Aromatic Hydrocarbon (PAH) Contamination:** Bio-piling can be used to remediate the soil contaminated with polycyclic aromatic hydrocarbons (PAHs). PAHs are a group of organic compounds that are toxic and carcinogenic. Bio-piling can be an effective way to breakdown PAHs into harmless compounds.
- **Pesticide Contamination:** For the remediation of contaminated soil with heavy metals, this technique is used. Heavy metals, such as lead, mercury, and cadmium, are toxic to humans and the environment. Bio-piling can be an effective way to immobilize heavy metals in the soil, reducing their toxicity and bioavailability. Microorganisms helps in making them less mobile and less harmful.
- **Chlorinated Solvent Contamination:** This technique is also used to remediate the chlorinated solvents. Chlorinated solvents, such as trichloroethylene (TCE) And perchloroethylene (PCE), are toxic and can be harmful to human health.
- **Landfarming:** Treating contaminated soil by spreading it over a large area and adding nutrients and microorganisms to promote degradation. This method is also used to treat organic pollutants, such as petroleum hydrocarbons and contaminated soil. The soil is aerated and irrigated to increase the activity of microorganisms, resulting in the biodegradation of pollutants.
- **Applications of Land Farming**
- **Treating petroleum-contaminated soil:** Landfarming is commonly is used to remediate soil that has been contaminated by petroleum products. The technique is effective for removing hydrocarbons and other petroleum compounds from soil.

- Remediating agricultural land: Landfarming can be used to remediate agricultural land that has been contaminated by pesticides or herbicides. By promoting the growth of microorganisms that break down these contaminants, landfarming can help restore the soil's fertility and productivity.
- Managing contaminated waste: Landfarming can be used to remediate waste that is contaminated with organic compounds. The waste is spread over a large area and microorganisms and encouraged to break down the contaminants over time.
- Remediating industrial sites: Landfarming can be used to remediate industrial sites that have been contaminated by chemicals or other hazardous materials. By promoting the growth of microorganisms that break down the contaminants, landfarming can help reduce the risk to exposure to these materials.

Bioreactors: Treating contaminated water by passing it through a system that contains microorganisms. This method is used for the treatment or the organic pollutants, heavy metals, and radioactive substances.

Applications of Bioreactors

Bioreactors landfills

- Bioreactors are used to accelerate the natural process of biodegradation in landfills by optimizing environmental conditions for microbial activity. Bioreactors landfills can reduce the amount of waste that needs to be transported to traditional landfills, as well as the amount of methane and other greenhouse gases that are produced.

Bioreactor composting

- Bioreactors are used to accelerate the composting process by optimizing environmental conditions for microbial activity. Bioreactor composting can produce high-quality compost in a shorter period, and can reduce the amount of waste that is sent to landfills.

Advantage of Bioremediation

There are various benefits of bioremediation

Eco-Friendly: In Context, bioremediation is a means to eliminate harmful environmental impacts. This benefits individual human health, and well as overall environmental system. Bioremediation helps clean up water sources, create healthier soil, and improve air quality around the globe.

Cost-Effective: If you are responsible for an area in need of remediation, you know that environmental interventions don't come cheap. Fortunately, bioremediation can be a highly cost-effective technology. Typically, the cost of treating a hazardous waste site using bioremediation is quite a bit lower than the cost of using conventional treatment methods.

Scalable: Bioremediation technology is easily scalable, treating a range of areas from small landfills to massive water treatment plants, For example, sewage treatment plants are the largest bioremediation enterprise in the world, with approximately 34 billion gallons of wastewater collected exactly how flexible bioremediation really is.

Limitations of Bioremediation

In Bioremediation not all compounds are susceptible to rapid and complete degradation. Biological processes are often highly specific. Important site factors required for success include the presence of metabolically capable microbial populations, suitable environmental growth conditions, and appropriate levels of nutrients and contaminants. Contaminants may be present as solids, liquids, and gases. Research is needed to develop and engineer bioremediation technologies that are appropriate for sites with complex mixtures of contaminants that are not evenly dispersed in the environment. Contaminants may be present as solids, liquids, and gases. Bioremediation often takes longer than other treatment options, such as excavation and removal of soil or incineration.