RANIGANJ GIRLS' COLLEGE

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Topic of the project: Different aspects of Air, Soil, Water, Noise pollution

A Project Report

Submitted by Semester-I students (Academic Year 2021-22)

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CERTIFICATE

This is to certify that this project titled "Different aspects of Air, Soil, Water, Noise pollution" submitted by the students for the award of degree of B.A. Honours/ Program is a bonafide record of work carried out under my guidance and supervision.

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CONCEPT

- Introduction.
- What is Bioremediation.
- Principle of Bioremediation.
- Factors of Bioremediation.
- Bioremediation strategies.
- Phytoremediation.
- Advantages of Bioremediation.
- Disadvantages of Bioremediation.

INTRODUCTION

Bioremediation is a "treatment that uses naturally occurring organisms to break down hazardous substances into less toxic or non toxic substances." Organisms used to perform the function of bioremediation are known as bioremediation. Over the last century, global industrialization, war, and natural processes have resulted in the release of large amounts of toxic compounds into the biosphere.

* Bioremediation *

• What is Bioremediation? :-

Bioremediation is the intentional use of Biological degradation procedures to remove or reduce the concentration of environmental pallutants from sites where they have been released. The concentrations of pallutants are reduce to levels considered acceptable to site owners and/or regulatary agencies. A bioremediation project or program should consider many aspects of the site, the contamination, the microorganisms, the environment, the goals and regulatory limit on contaminants set by the appropriate agencies (MoEE, EPA, etc.) and features that would impact on the successful outcome of the project.

Bioremediation Processes

Contamination
- Sources
- Chemistry
- Concentration
- Transport
- Mixtures
- Sorption

Environment
- Soil
- Groundwater
- Surface Water
- Air
- Abiotic degradation
- Transport
- Heterogeneity
- Sorption
- Valatality

Processes Engineering & Monitoring
- In-situ Treatment: Aquifers
- Pump & Treat
- Percolation
- Reinjection
- Air sparging
- Natural Attenuation
- In-situ Phase Treatments: Soils
- Soil vapour Extraction Bio Venting
- Solid Phase Bioremediation Land Treatment Composting
- Slurry Phase Bioremediation Reactors
- Vapour Phase Bioremediation Biofilters Tricking Filters
- Other Processes
- Monitoring & Verification Procedures

Fig. 1. Overview of Bioremediation process

- **Principles of Bioremediation :-**

1. Environmental biotechnology is not a new field; composting and wastewater treatments are familiar examples of old environmental biotechnology. However, recent studies in molecular biology and ecology offer opportunities for more efficient biological processes. Notable accomplishments of these studies include the clean-up of polluted water and land areas.

2. By definition, 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 microorganisms may be indigenous to a contaminated area or they may be isolated from elsewhere and brought to the contaminated site. Contaminant compounds are transformed 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 we have a process known as bioaugmentation.

For bioremediation to be effective, microorganisms must enzymatically attack the pollutants and convert them to harmless product. As bioremediation can be effective only where environmental conditions permit microbial growth and activity, its application often involves the manipulation of environmental parameters to allow microbial growth and degradation to proceed at a faster rate.

Like other technologies bioremediation has its limitations. Some contaminants, such as chlorinated organic or high aromatic hydrocarbons, are resistant to microbial attack. They are degraded either slowly or not at all, hence it is not easy to predict the rates of clean-up for a bioremediation exercise; there are no rules to predict if a contaminant can be degraded. Bioremediation techniques are typically more economical than traditional methods such as incineration, and some pollutants can be treated on site, thus reducing exposure risks r clean-up personnel, or patentially accidents. nce bioremediation is based on natural atten ation the public considers it more acceptable than her technologies.

Factors of Bioremediation :-

Microbial Populations for Bioremediation Processes

croorganisms can be isolated from almost any vironmental conditions. Microbes will adapt and ow at subzero temperatures, as well as extreme at, desert conditions, in water, with an excess oxygen, and in anaerobic conditions, with the esence of hazardous compounds or on any waste eam. We can subdivide these microorganisms to the following groups:

Aerobic: In the presence of oxygen. Examples aerobic bacteria recognized for their degradative lities are Pseudomonas, Alcaligenes, Sphingomonas, odococcus, and Mycobacterium, These microbes e often been reported to degrade pesticides d hydrocarbons, both alkanes and polyaromatic ompounds. Many of these bacteria use the antaminant as the sole source of carbon and nergy.

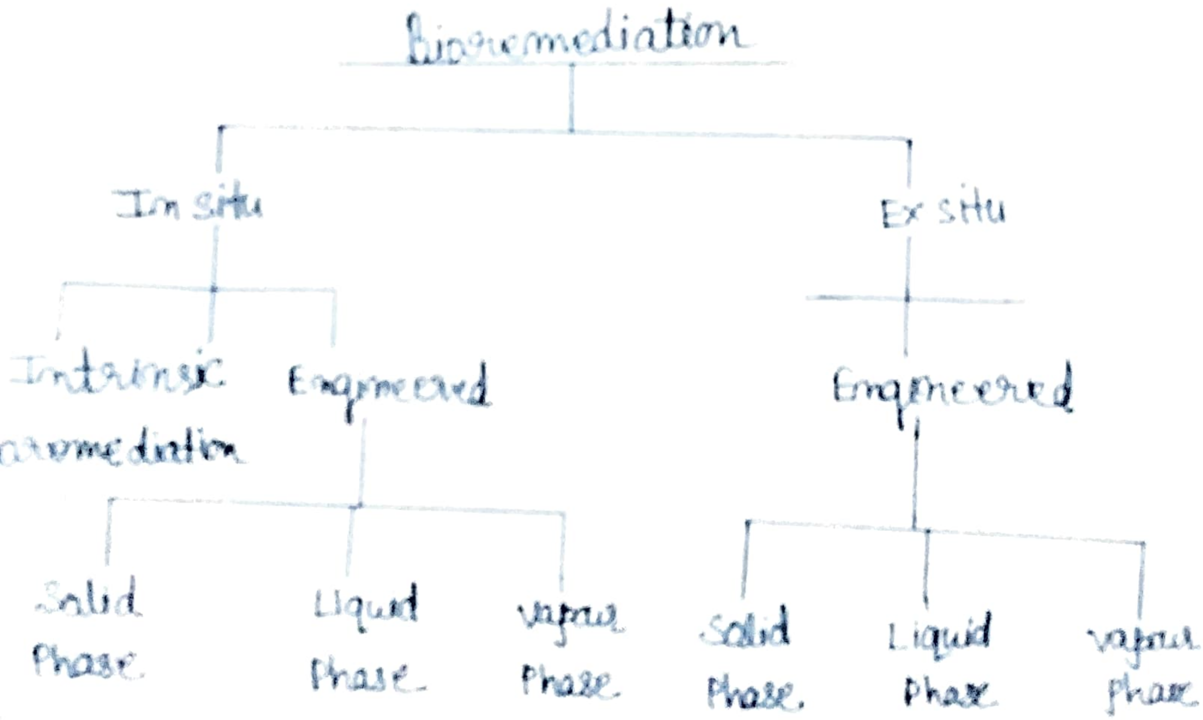
Anaerobic: In the absence of oxygen. Anaerobic bacteria are not as frequently used as aerobic bacteria. There is an increasing interest in anaerobic bacteria used for bioremediation of polychlorinated biphenyls (PCBs) in river sediments, dechlorination of the solvent trichloroethylene (TCE), and chloroform.

Ligninolytic fungi: Fungi such as the white rot fungus Phanaerochaete chrysosporium have the ability to degarde an extremely diverse range of persistent or toxic environmental pollutants. Common substrates used include straw, saw dust, or corn cobs.

Methylatrophs: Aerobic bacteria that grow utilizing methane for carbon and energy. The initial enzyme in the pathway for aerobic degradation, methane monooxygenase, has a broad substrate range and is active against wide range of compounds, including the hlorinated aliphatics trichloroethylene and 1.2-ichloroethane.

Bioremediation Strategies :-

he possible types of bioremediation activities all into two main categories: ex situ and in-itu. In-situ bioremediation occurs in the soil, roundwater of other environment without removal the contaminated material. In contrast, ex-situ oremediation entails the removal of all or rt of the contaminated material for treatment



In-situ Bioremediation

Fig 2. Different types of bioremediation activities

In situ bioremediation means there is no need to excavate or remove soils or water in order to accomplish remediation. Most often, in situ bioremediation is applied to the degradation of contaminants in saturated soils and groundwater. It is a superior method to cleaning contaminanted environments since it is cheaper and uses harmless microbai organisms to degrade the chemicals. Chemotaxis is important to the study of in-situ bioremediation because microbial organisms with chematactic abilites can move into an area containing contaminants. So by enhancing the cell's chemotactic abilities, in-situ bioremediation will become a safer method in degrading harmful compounds.

Intrinsic bioremediation: This approach deals with stimulation of indigenous or naturally occurring microbial population by feeding them nutrients and oxygen to increase their metabolic activity.

Engineered in situ bioremediation: The second approach involves the indroduction of certain microorgansims to the site of contamination. When site conditions are not suitable, engineered

ystem have to be introduced to that particular site
ngineered in situ bioremediation accelerates the
gradation process by enhancing the physicochemical
ndition to encourage the growth of microorganisms
xygen, electron acceptors and nutrients (eg: nitrogen
d phosphorus) Promote microbial growth.
he most important In-situ bioremediation
reatments are:

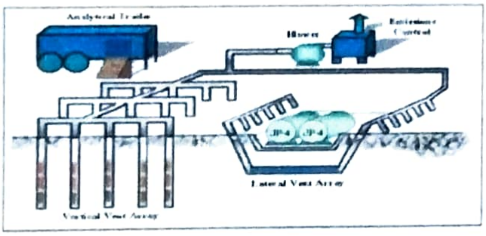


Fig. 3. Typical Bioventing System

oventing -
t is the most common in situ treatment and
volves supplying air and nutrients through wells
contaminated soil to stimulate the indigenous
cteria. Bioventing employs low air flow rates
d provides only the amount of Oxygen neccessary
r the biodegradation while minimizing volatiliz-

tion and release of contaminants to the atmosphere
t works for simple hydrocarbons and can be used
here the contamination is deep under the surface.

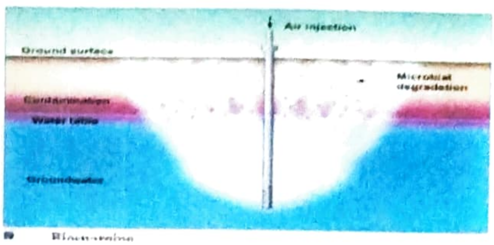


Fig. 4. Biosparging enhances the microbial

osparging -

n involves the injection of air under pressure
low the water table to increase groundwater
ygen concentration and enhance the rate of
ological degradation of contaminants by naturally
curring bacteria. Biosparing increases the mixing
the saturated zone and thereby increases
e contact between soil and groundwater. The ease
d low cost of installing small-diameter air
jection points allows considerable flexibility in
e design and construction of the system.

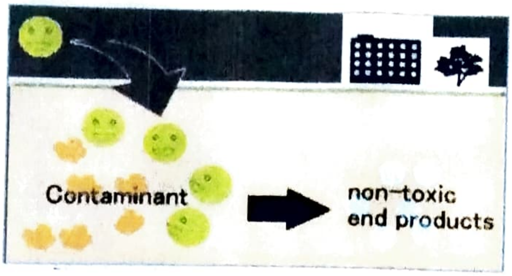


Fig.5 Bioaugmentation

Bioaugmentation –

Bioaugmentation is a technique that is mainly used in the saturated zone of the soil. For the introduction of the bacteria, it is imperative that permeable soild layers are present. The bacteria are added to the soil when it is demonstrated that the needed bacteria are not present at the contaminated site. The range of influence of the added bacteria depends on the infiltration technology, and on the bacteria. They might stick to the infiltration well, or do they have the tendency to migrate away from the infiltration well. Providing pre-grown microorganisms to a contaminated site that can degrade the contaminated micro organisms is called bioaugmentation. This can be performed under both aerobic and anaerobic conditions. The addition of nutrients, electron acceptors, or electron donors might also the be necessary.

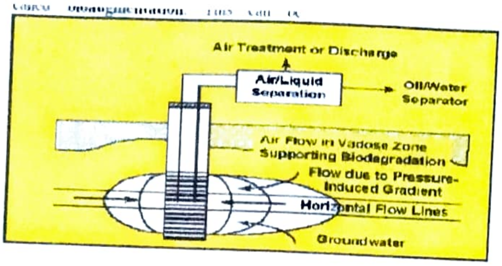


Fig 6. Typical is situ Bioslurping system

Bioslurping - It is a unique in situ treatment technique in that it also treats free product phases floating on top of the groundwater. This technique applies a vacuum to extract soil vapor, water, and free ~~da~~ product from the subsurface. Each of those substances is then separated and properly disposed of.

Passive Treatments - Passive techniques incude activated zones, Bioscreens, Reactive walls and reactive trenchs. These techniques can be used when removing contaminants from nonhomogenous soils. These techniques are attractive because they have high longevity, no significant maintence, and no nutrient replenishment

3. Ex-Situ Bioremediation

Ex situ bioremedition processes require excavation of contaminated soil or pumping of groundwater to facililate microbial degradation. Depending on the state of the contaminant to be removed ex situ bioremediation is classified as;

- Solid phase System (Including Land farming Composting, Biopiling)
- Slurry Phase system (Including Solid-Liquid suspensions in Bioreactors)

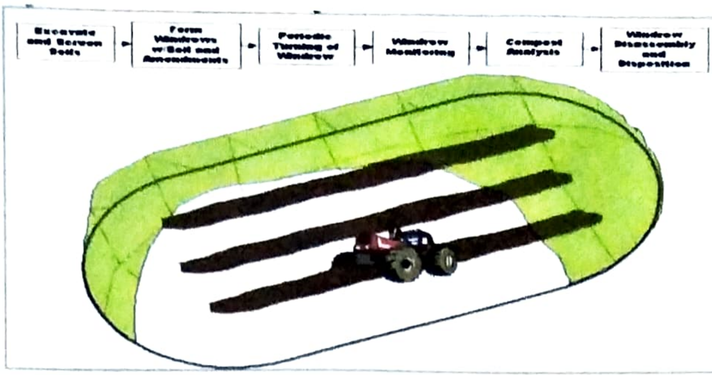
Solid phase system

The most important ex-situ bioremediation treatment under solid phase system are: Land farming, composting, Biopiling

Fig. 7. Typical land farming treatment unit.

• Land farming -

It is a simple teachnique in which contaminated soil is excavated and spread over a prepared bed and periodically tilled until pollutants are degraded. The goal is to stimulate indigenous biodegradative microorganisms and facililate their aerobic degradation of contaminants. In general, the practice is limited to the treatment of superficial 10-35 cm of soil. Since landfarming has the potential so reduce monitoring and maintenance costs, as well as clean-up liabilities, it has received much attention as a disposal alternative.



· Composting -

Is a technique that invales combining contaminated soil with nonhazardous organic amendments such as manure or agricultural wastes. The presence of these organic materials supports the development of a rich microbial population and elevated temperature characteristic of composting.

PHyToremediation :-

Phytraremediation - Vegetation based remediation shows potential for accumutating immobilizing, and transforming a low level of persistent contaminants. In natural ecosystems, plants act as filters and metabolize substances generated by nature. Phytoremediation is an emerging technology that uses plants to remove contaminants from soil and water. We can find five types of phytoremediation techniques, classified based on the contamiant fate: Phytoextraction, Phytotransformation, Phytostabilization, Phytodegradation, rhizofiltration, even if a combination of these can be found in nature.

1) Phytoextraction - Phytoextraction or phytoaccumulation is the process used by the plants to accumulate contaminants into the roots and aboveground shoots or leaves. This technique saves tremendous remediation cost by accumulating low levels of contaminants from a widespread area. Unlike the degradation mechanisms, this process produces a mass of plants and contaminants (usually metals) that can be transported for disposal or recycling.

2.) Phytotransformation – Phytotransformation or
phytodegradation refers to the uptake of organic
contaminants from soil, sediments, or water and,
subsequently, their transformation to more stable,
less toxic, or less mobile form. Metal chromium
can be reduced form hexavalent to trivalent
chromium, which is a less mobile and non carcino-
genic form.

3.) Phytostabilization – Phytostabilization is a
technique in which plants reduce the mobility
and migration of contaminated soil. Leachable
constituents are adsorbed and bound into the
plant from which the contaminants will not
reenter the environment.

4.) Phytodegradation – Phytodegradation or rhizo-
degradation is the breakdown of contaminants
through the activity existing in the rhizosphere.
This activity is due to the presence of proteins
and enzymes produced by the plants or by
soil organisms such as bacteria, yeast, and
fungi. Rhizodergradation is a symbiotic relationship

that has evoled between plants and microbes. Plants provide nutrients necessary for the microbes to thrive, while microbes provide a healthier soil environment.

5.) Rhizofiltration - Rhizofiltration is a water remediation technique that involves the uptake of contaminants by plant roots. Rhizofiltration is used to reduce contaminantion in natural wethands and estuary areas.

Limitation of phytoremediation technology -

Phytoremediation is well suited for use at very large field sites where other methods of remediation are not cost effective or practicable; at sites with a low concentration of contaminants where only polish treatment is required over long periods of time; and in conjunction with other long periods technologies where vegetation is used as a final cap and closure of the site. There are some limitation to the technology that it is selected for site remediation, potential contamination of the vegetation and food chain, and difficulty establishing and maintaining vegetation at some sites with high toxic levels.

- **ADvanTages of Bioremediation :-**

1.) Bioremediation is a natural process and is therefore perceived by the public as an acceptable waste treatment process for contaminated material such as soil. Microbes able to degrade the contaminant is present; when the contaminant is degraded, the biodegradative population declines. The residues for the treatment are usually harmless products and include carbon dioxide, water, and cell biomass.

2.) Theoretically, bioremediation is useful for the complete destruction of a wide variety of contaminants. Many compounds that are legally considered to be hazardous can be transformed to harmless products. This eliminates the chance of future liability associated with treatment and disposal of contaminated material.

3.) Instead of transferring contaminated from one environmental medium to another, for example destruction of target pollutants is possible.

4.) Bioremediation can often be carried out on site, often without causing a major disruption of normal activites. This also eliminates the need to transport quantities of waste off site and the potential threats to human health and the environment that can arise during transportation.

5.) Bioremediation can prove less expensive than other technologies that are used for clean-up of hazardous waste.

Disavantages of Bioremediation :-

1.) Bioremediation is limited to those compounds that are biodegradable. Not all compounds are susceptible to rapid and complete degradation.

.) There are some concerns that the products of biodegradation may be more persistent or toxic than the parent compound.

3) 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.

4) It is difficult to extrapolate from bench and pilot-scale studies to full-scale field operation.

5) 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.

6) Bioremediation often takes longer than other treatment options, such as excavation and removal of soil or incineration.

Conclusion :-

Despite its short-comings, its pertinence in this world is unquestionable in the light of present day environmental hazards. Bioremediation provides a technique for cleaning up pollution by enhancing the same biodegradation processes that occur in nature. So by developing an understanding of microbial communities and their response to the natural environment and pollutants, expanding the knowledge of the genetics of microbes to increase capabilities to degrade pollutants, conducting field studies of new bioremediation techniques which are cost effective, and dedicating sites which are set aside for long term research purpose, these opportunities offer potential for signi-ficant advances. There is not doubt that bioremediation is in the process of paving a way to greener pastures!

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