

## Types of Techniques Involved in Bioremediation

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### INTRODUCTION

Bioremediation is a process where biological organisms are used to remove or neutralize an environmental pollutant by metabolic process. The “biological” organisms include microscopic organisms, such as fungi, algae and bacteria, and the “remediation”—treating the situation.

### Ex situ bioremediation techniques

These techniques involve excavating pollutants from polluted sites and subsequently transporting them to another site for treatment. Ex situ bioremediation techniques are usually considered based on: the cost of treatment, depth of pollution.

#### Biopile

Biopile mediated bioremediation involves above-ground piling of excavated polluted soil, followed by nutrient amendment, and sometimes aeration to enhance bioremediation by basically increasing microbial activities.

#### Windrows

As one of ex situ bioremediation techniques, windrows rely on periodic turning of piled polluted soil to enhance bioremediation by increasing degradation activities of indigenous and/or transient hydrocarbonoclastic bacteria present in polluted soil. The periodic turning of polluted soil, together with addition of water bring about increase in aeration, uniform distribution of pollutants, nutrients and microbial degradative activities.

#### Bioreactor

Bioreactor, as the name implies, is a vessel in which raw materials are converted to specific product(s) following series of biological reactions. There are different operating modes of bioreactor, which include: batch, fed-batch, sequencing batch, continuous and multistage. The choice of operating mode

depends mostly on market economy and capital expenditure.

#### Land farming

Land farming is amongst the simplest bioremediation techniques owing to its low cost and less equipment requirement for operation. In most cases, it is regarded as ex situ bioremediation, while in some cases, it is regarded as in situ bioremediation technique. This debate is due to the site of treatment.

### Enhanced in situ bioremediation

#### Bioventing

This technique involves controlled stimulation of airflow by delivering oxygen to unsaturated (vadose) zone in order to increase bioremediation, by increasing activities of indigenous microbes. In bioventing, amendments are made by adding nutrients and moisture to enhance bioremediation with the ultimate goal being to achieve microbial transformation of pollutants to a harmless state.

#### Phytoremediation

This technique relies on the use of plant interactions (physical, biochemical, biological, chemical and microbiological) in polluted sites to mitigate the toxic effects of pollutants.

#### Biosparging

This technique is very similar to bioventing in that air is injected into soil subsurface to stimulate microbial activities in order to promote pollutant removal from polluted sites.

### CONCLUSION

Biopile mediated bioremediation involves above-ground piling of excavated polluted soil, followed by nutrient amendment. As one of ex situ bioremediation techniques, windrows rely on periodic turning of piled polluted soil to enhance bioremediation.

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