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A Brief Overview of Contaminated Soil Remediation Methods

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Abstract

Soil and sediment remediation has been achieved by techniques including mechanical, biological and thermal processes and is still practiced today. However interest on the use of intrinsic methods for soil and sediment remediation is currently gaining momentum with the aim to minimize the adverse effects of soil contaminants. Scientific research is under progress to devise novel remediation methods known as technical soil protection methods to minimize or completely eliminate soil pollutants from the environment.

***Keywords**: Soil Vapor Extraction, Capping, Solidification, Thermal treatment, Stabilization*

Introduction

Technical soil protection methods have become an acknowledged integrated scientific approach for the remediation of soil and sediment pollutants by collaborating knowledge from diverse areas such as engineering, chemistry, microbiology, soil biology, geology and environmental sciences [1]. For soil remediation it is crucial to understand the nature of soil, characterization of its organic matrices, sorption/desorption potential of soil, soil microbiome etc [2]. In case of contaminated sediments, collective approaches such as dehydration, shrinkage, permeability alterations, phytostabilization is applied to deal with the related pollution problems [3]. Alternative disposal techniques such as underground storage in a salt cavern and subaqueous disposal/capping are another soil pollution management approaches employed for separating contaminated sediments to prevent contaminants release into the environment [4].

Soil Remediation Approaches

Soil contamination has been handled using the following alternatives:

- Abandoning of contaminated soil and restricting the use of contaminated site
- Capping or encapsulating the soil in situ with water-resistant material and covering with a layer of clean topsoil
- Excavating the contaminated soil and disposing of it at a hazardous waste landfill
- Treating the contaminated soil using ex situ methods [5-8]

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Choice of soil remediation approaches

Selection of soil /sediment remediation approaches is dependent on soil type, soil composition physical properties of soil, contaminant nature, feasibility of contaminant isolation, handling intensity, cost etc [9]. Sometimes it is possible for some biological and tinting methods to extremely alter the existing chemical properties of soil by addition of chemicals and nutrients to enhance the growth of soil microbes [10]. On the other hand land use restrictions and in-situ soil flushing methods could sometimes be the cause of groundwater contamination [11]. While thermal soil treatment methods destroy the soil's organic and clay components causing oxidation of compounds yielding problematic products [12]. Sandy and rocky soils can possibly be used as backfill; the clayey substrates with a high share of pelletized material are not appropriate for many types of construction stresses. Therefore, it does not seem beneficial to strive for reusing remediated subsoil [13]. The covering of areas intended for horticultural and agricultural use with low- or uncontaminated topsoil is usually a simpler and more economical solution [14].

Types of remediation methods

- In-situ: Contaminated soil is treated at the site where it is occurring [15]
- Ex-situ: These methods require the excavation of contaminated soil [16]

Remediation Methods

Following are some soil and sediment remediation methods practiced today:

Excavation and removal: Process of excavation involves loosening, quarrying, loading, hauling, unloading and disposing [17].

Construction of barrier systems: A major remediation technology to control existing contamination by avoiding large-scale contaminant migration to reduce or eliminate contaminants [18]

Capping: it prevents infiltration of precipitation into the contaminated area [19].

Solidification: it involves mixing of bonding agent with the contaminant to create a mechanically solid product [20]

Stabilization: it converts the contaminant material into a stable form to limits its solubility [21]

Soil vapor extraction: Soil vapor technologies were employed for the removal of highly volatile substances with high vapor pressures from the unsaturated zone [22]. It is generally considered relatively trouble-free and requires low maintenance [23].

Soil washing: The soil contaminated with organic pollutants and heavy metals is cleaned with washing agents to efficiently remove inorganic contaminants from the soil [24].

Steps involved-

- Homogenization of contaminants, size reduction through screening
- Solids and solution interface in a fluidized bed reactor
- Separation of solution and the decontaminated solids
- Post-treatment by washing, precipitation, volatilization, adsorption, incineration, chemical or microbiological treatment
- Recovery of extraction agent [25-27]

Electrochemical method: Heavy metals and other contaminants can be removed from the soil with the help of electro-kinetic phenomena (electrosmosis, electrophoresis, electrolysis) in a continuous electrical produced in the contaminated soil [28]

Biological treatment: Microbiological bioremediation can be applied in a variety of ways for soil contaminant specific site remediation by using specialized strains of bacteria with particular zest for consuming contaminants [29].

Thermal treatment: In general, thermal processes are used where soils are contaminated with volatile or combustible substances such as solvents, petroleum, coal derived hydrocarbons, BTEX, aromatics, PAHs, highly volatile CFCs, chlorinated herbicides, pesticides etc [30]. But these methods are expensive because the subsequent treatment steps for the gases require significant expenditures to destroy or concentrate the contaminants (afterburning and multi-stage gas-scrubbing) [31]. All thermal treatment processes are characterized by the need for additional fuel, e.g., heating oil, natural gas, or electricity [32].

Conclusion

Thus the use of these novel soil remediation methods known as technical soil protection methods reduces or completely eliminates soil contaminants either in-situ or ex-situ from the environment.

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