

Review on Remediation Technology of Heavy Metal Contaminated Soil

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Abstract: With the development of global social economy, there are also problems of soil heavy metal pollution. It will not only destroy the original soil quality, but also cause harm to our health and affect the growth and development of animals and plants. Therefore, the remediation of soil pollution has become an important research field. This paper expounds the current common soil remediation technology, comprehensively evaluates the corresponding remediation technology, and preliminarily puts forward the development suggestions of soil remediation technology in contaminated sites.

Keywords: Heavy metals, Soil leaching, Environmental treatment.

1. Introduction

As an important part of the ecological environment, soil is an indispensable place for animals, plants and human beings. Healthy soil can conserve water and purify water quality, and has important ecological service functions [1]. In recent years, China's economy has developed rapidly, but there has also been a problem of heavy metal pollution. Heavy metals will enter the food chain after being absorbed by crops, continuously enrich or enter water, soil and atmosphere in some ways, resulting in crop reduction and deterioration of the living environment. At the same time, due to the existence of heavy metals in the soil, it is easy to be affected by human activities, and the enrichment and migration of heavy metals are becoming more and more serious. How to control soil heavy metal pollution has become a hot topic in the field of agriculture, ecology and environmental science [2-4].

At present, the methods of treating heavy metal contaminated soil can be divided into two kinds according to the mechanism, one is to use the corresponding fixing agent and modifier to change the occurrence form of heavy metals in soil, reduce the mobility and bioavailability of heavy metals in soil, so as to achieve the purpose of remediation [5-6]. The second is to comprehensively use physical, chemical and biological methods to remove pollutants from the soil, so that their retention can reach the background value range allowed by the soil environment. The specific technical measures include phytoremediation, microbial remediation, thermal desorption, chemical leaching, solidification-stabilization, oxidation-reduction, electro-chemical-combined remediation [7-9].

Soil remediation technology is the key to determine the success or failure of contaminated site remediation. The choice of soil remediation technology is not only affected by the characteristics of site pollution, but also by political, economic, social and other factors. At present, although there are many soil remediation methods, some technologies are not suitable for use in contaminated soils due to remediation cycles, secondary risks, or other constraints. For example, phytoremediation technology is rarely applied to industrial contaminated soil due to its limitation of repair depth and repair cycle. For urban contaminated sites, driven by the economic value of urban land, remediation technology should

have the characteristics of short cycle, low secondary risk, high stability and little damage to soil structure.

2. Contaminated Soil Remediation Technology Section Headings

2.1. Solidification and stabilization technology

Stabilized solidification remediation technology is mainly to reduce the exchangeable content of heavy metals in the soil environment or limit their migration by curing agents, thereby inhibiting the dissolution, migration, toxicity and effectiveness of heavy metals in the soil. [10].

The principle is to use a certain mechanical force to add a curing agent or a stabilizer to the contaminated soil in situ. Under the mutual integration of the two, it helps it to undergo physical or chemical reactions with pollutants, control the activity of heavy metals, ensure that its chemical properties are not active, and reduce the activity range of heavy metals in the soil.

Solidification or stabilization is a group of technologies that point to the addition of one or several types of solidification or stabilization agents to heavy metal contaminated soil to prevent or reduce the release of toxic heavy metals in soil through physical or chemical processes. Solidification is to coat the toxic heavy metals in the soil by adding agents to form a relatively stable form and limit the release of heavy metals in the soil. Stabilization is the addition of stabilizing agents to the soil to reduce the mobility and bioavailability of heavy metals in the soil by adsorption, precipitation (coprecipitation), and complexation of heavy metals. The effect of curing or stabilization is generally referred to as passivation. After heavy metals are solidified / stabilized, they can not only reduce their migration to deep soil and groundwater, but also reduce the accumulation of heavy metals in crops and reduce the harm of heavy metals to organisms and humans through the food chain. The key to the solidification or stabilization of heavy metals is to select suitable agents with solidification or stabilization effects.

This technology is relatively easy to operate, but it will destroy the original soil structure, and the demand for curing agent and stabilizing agent is large, so it is suitable for the repair of small contaminated area. But heavy metals in the soil cannot be completely removed.

2.2. Soil leaching technology

Soil leaching refers to the removal of heavy metal pollution in soil by eluent. In the process of washing, the selection of efficient washing additives is the key to successful washing.

Leaching method can be used for the treatment of large area and heavy polluted soil, especially. The effect is better in light soil and sandy soil, but the permeability coefficient is very low.

Soil leaching technology is divided into in-situ soil leaching and ectopic soil leaching. In situ soil leaching refers to the addition of soil leaching agent to heavy metal contaminated soil, so that it penetrates and combines with pollutants, through a series of dissolution and other effects, the formation of migratory compounds, and then the solution containing pollutants is extracted and collected for treatment. Soil leaching technology needs to dig out the contaminated soil first, screen and use the eluent clearly, and then transport the clean soil back. In situ soil leaching technology is suitable for permeable soil, while ectopic soil leaching is more suitable for combination with other remediation technologies. At present, the common eluents are mainly divided into four categories : chelating agent, acid-base solution, complexing agent and surfactant. It is necessary to select the appropriate eluent for the contaminated land type. The remediation technology highlights the advantages of high efficiency, easy operation and no direct contact with pollutants. Different eluents have different mechanisms for removing pollutants. Therefore, it is necessary to comprehensively consider the types and forms of pollutants in the soil when selecting the appropriate eluent. The main leaching mechanism of inorganic eluent is to destroy the adsorption of heavy metals by soil particles through chemical actions such as ion exchange, acid hydrolysis, and complexation, and resolve the heavy metals into the leachate. The commonly used are HCl, HNO₃, H₂SO₄, H₃PO₄, etc. Commonly used organic acids are oxalic acid, citric acid, tartaric acid, etc., which promote the desorption of heavy metal ions through chelation of hydroxyl groups and complexation of heavy metal ions. The chelating agent is a synthetic chelating agent of aminopolycarboxylic acids, such as ethylenediamine tetraacetic acid (EDTA), aminotriacetic acid (NTA), etc., but this kind of eluent will remain in the soil during the leaching process, and then pollute the soil[11]. Surfactants mainly enhance the solubility and fluidity of pollutants, so that heavy metals in soil are dissolved and collected. The effect of eluent concentration on leaching efficiency, in general, the greater the concentration, the higher the leaching efficiency. However, in practice, the increase of the concentration of the eluent will reduce the amount of eluent entering the soil, and the leaching effect is not necessarily the better, and the cost should be considered.

2.3. Bioremediation technology

Among the widely used soil heavy metal pollution remediation technologies, bioremediation technology has the least impact on the repaired soil ecosystem. It has many advantages such as low repair cost, good treatment effect, no secondary pollution risk, no limitation of soil type and large-scale application. Phytoremediation and microbial remediation are the main means of bioremediation technology for soil heavy metal pollution. Phytoremediation is the use of plants to fix, transform or root filter heavy metal contaminated soil, so that the content of heavy metals in soil is reduced. The phytoremediation method can use the plant

metabolic function to inhale the pollutants into the body and then convert the degradation repair, or use the plant 's own transpiration, plant root adsorption, filtration function to repair the heavy metals in the land. Microbial remediation is to use microbial communities for microbial metabolism to reduce the content of heavy metals in soil. Microbial remediation improves pollution by bioaccumulation and adsorption of heavy metals, or uses microbial community resistance to transform heavy metals to reduce pollution. Both repair methods are green and convenient, and these two methods can be used more in soil repair in the future.

2.4. Electric repair technology

Electrokinetic remediation is an effective and potential remediation technology for heavy metal contaminated soil. Electrokinetic remediation is a technology that directs the insertion of an electrode into a heavy metal contaminated soil to apply a DC voltage to cause heavy metal ions to undergo electromigration, electroosmotic flow, electrophoresis and other processes under the action of an electric field, so that it is enriched near the electrode and then derived from the solution and subjected to appropriate physical or chemical treatment to achieve contaminated soil cleaning. The technology has the characteristics of simple operation, various pollutants and relatively low cost, and has good development prospects. Electric remediation is a kind of in-situ remediation technology for decontaminating soil pollution researched by Louisiana State University in the United States, which is developing faster in some European and American countries and has entered the commercialization stage. However, electrokinetic remediation technology is still mainly in the laboratory research stage, and there are few application cases in contaminated sites[12].

3. Conclusion

Heavy metal pollution in soil has seriously affected the development of agriculture and human health. The remediation of heavy metals in soil is urgent. The current soil remediation methods have their own advantages and disadvantages. Due to the differences in soil types and pollutant properties, the problem of soil heavy metal pollution is complex and changeable, and a single remediation technology is gradually difficult to meet various remediation requirements. Therefore, it is very important to choose the appropriate remediation method according to the type of soil and the nature of pollutants, and the synergistic remediation combined with multiple remediation methods will be the future development direction.

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