Scientific Research Publishing

Open Journal of Applied Sciences, 2019, 9, 115-120
http://www.scirp.org/journal/ojapps
ISSN Online: 2165-3925
ISSN Print: 2165-3917

Study on Soil Remediation Technology of Cadmium Contaminated Site

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How to cite this paper: Han, B.F. (2019) Study on Soil Remediation Technology of Cadmium Contaminated Site. *Open Journal of Applied Sciences*, **9**, 115-120.
https://doi.org/10.4236/ojapps.2019.93010

Received: March 7, 2019
Accepted: March 24, 2019
Published: March 27, 2019

Abstract

This paper focuses on the status quo of heavy metal cadmium pollution sites, analyzes and summarizes the physical, chemical and bioremediation technologies of cadmium contaminated soil, and carefully analyzes the advantages and disadvantages of each repair technology. It pointed out the need to develop scientific, efficient and comprehensive restoration management techniques.

Keywords

Cadmium Pollution, Soil, Repair Technology

1. Introduction

Since the 1920s, environmental pollution problems of cadmium have begun to appear. Cadmium is a silvery white shiny heavy metal with high toxicity, long duration, migration and bioaccumulation. There is a large amount of acidic wastewater in the mining, smelting, heavy metal tailings, smelting waste and slag heap of lead-zinc mines. The various heavy metal ions dissolved in these acidic wastewaters include metal cadmium. Wastewater enters the soil through mine drainage and rainfall, indirectly or directly causing the cadmium content in the industrial site to exceed the environmental standards. Cadmium pollution not only affects the atmosphere, water and agricultural production, but also can cause chronic poisoning by entering the human body through migration and enrichment in the food chain, and induce genetic mutations and cancer. In this paper, the system is suitable for the cadmium-contaminated site remediation technology, in order to provide a scientific and reasonable basis for the later work of treating and repairing cadmium-contaminated sites.

2. The Occurrence of Cadmium in Soil

The occurrence and shape of cadmium in soil are not only related to the nature and content of the element itself, but also depend on the physical and geographical conditions of its existence, soil type and its properties, soil composition (such as organic matter, clay minerals, ferromanganese oxides, carbonates and microorganisms), soil environmental conditions. Cadmium undergoes adsorption, desorption, dissolution, aggregation, complexation and adsorption after entering the soil, which causes it to exist in various forms in the soil. According to the chemical form, it can be divided into exchangeable state: carbonate-bound state, iron-manganese oxide-bound state, and organic bound state [1] [2] [3].

3. Soil Remediation Technology for Cadmium Contaminated Sites

Cadmium soil pollution repair can be divided into physical repair technology, chemical repair technology and bioremediation technology according to different technical principles.

3.1. Physical Repair Technology

Physical repair is a method of removing contaminants from contaminated media or reducing environmental risks by physical methods such as dilution, heating, and solidification of contaminated soil. Common physical repair methods include guest soil method, thermal analytical repair technology, vitrification repair technology and electric repair technology, which does not change the chemical properties of the pollutants.

3.1.1. Soil Change Method

The soil replacement method mainly reduces the concentration of cadmium by replacing the original cadmium-contaminated soil by replacing the fresh soil with good fertility, and transferring the contaminated soil to reduce the risk of cadmium-contaminated soil to the surrounding environment. The method is simple in principle, strong in operability and can reduce the concentration of pollutants below the control level in a short time, but this method does not change the mobility and bioavailability of pollutants in the soil, so it is often required in engineering construction [4] [5]. In combination with other remediation technologies and prevention and control barriers, it is also necessary to formulate a reasonable disposal plan to prevent secondary pollution to the environment.

3.1.2. Vitrification Repair

The cadmium-contaminated soil vitrification repair technology is to treat the soil contaminated with cadmium in a high temperature and high pressure environment for a period of time, and then cool it to form a vitreous substance. This material is generally stable, and cadmium contaminants in the soil are fixed to achieve a repair method for migration of cadmium-contaminated soil.

3.1.3. Electric Repair

Electro-repair technology refers to inserting electrodes at both ends of cadmium-contaminated soil to form a certain electric field gradient in the soil. The cadmium is transferred to the cathode or anode through the electroosmosis and electromigration of the electric field, and the electrode is placed on the electrode after electro-deposition. Precipitation on the stick to achieve attenuation or removal of cadmium contaminated soil [6]. This technology is a new type of physical repair technology with short cycle and high efficiency. It has been widely concerned and studied in recent years. However, the pH, permeability, and electrolyte materials of the soil affect its removal efficiency. The high cost and high energy consumption are also the constraints of this method.

3.2. Chemical Repair Technology

Chemical remediation of cadmium-contaminated soil refers to the change of the presence of cadmium in soil, soil redox sites, pH, etc. by adding chemical agents and improvers to cadmium-contaminated soil. Reduce the bioavailability of cadmium by separation, adsorption, transformation, degradation, etc., and reduce the harm of cadmium. At present, chemical repair technology mainly includes chemical leaching technology, its curing/stable repair technology. Commonly used substances in chemically repaired cadmium-contaminated soils include phosphates, limes, and silicates. Chemical repair has the advantages of in situ repair, simple and easy operation, but because it only changes the presence of cadmium in the soil, cadmium may be reactivated under certain conditions, and it is difficult to achieve permanent repair. Therefore, chemical remediation measures are only applicable to areas with low levels of cadmium contamination.

3.2.1. Rinsing Repair

Cadmium-contaminated soil leaching repair technology is the use of injection wells and other eluents or chemical additives. The leaching and repairing technology of cadmium-contaminated soil is to use the injection well to infiltrate the eluent or chemical auxiliary eluent under the action of gravity or external force, so that the cadmium in the contaminated soil is fully combined with it, and desorbed by the eluent. The core of this method of chelation, dissolution or immobilization is to find an economical, easy-to-produce eluent.

3.2.2. Curing/Stable Repair

Curing/stabilizing repair is a series of precipitation-adsorption, ion exchange, humification and other oxidation-reduction reactions by adding a fixative to the contaminated soil to fully mix the cadmium pollutants in the soil, and changing the existing form of cadmium in the soil, to reduce its migration and bioavailability in soil, and to reduce the biological toxicity of cadmium to animals and plants. At present, the fixed repair technology has the advantages of short cycle, quick effect and stable repair effect. However, this method does not completely remove cadmium from contaminated soil, only changes its occurrence state, and with the change of soil environment, it is easy to cause secondary pollution.

3.3. Bioremediation Technology

Cadmium-contaminated soil bioremediation technology refers to the absorption, inhibition, transformation and improvement of contaminated soil by utilizing certain characteristics of the organism. The bioremediation of cadmium-contaminated soil is generally divided into three types: phytoremediation, microbial remediation and animal remediation.

3.3.1. Phytoremediation Technology

Plants can not only use the secretion or adsorption activities of roots, but also reduce the mobility and bioavailability of soil cadmium. They can also absorb cadmium in soil through plant roots and enrich in branches, stems and leaves, and then continuously harvest the branches and stems of plants. There by reducing the soil cadmium content. At present, the internationally recognized super-accumulative plants with good cadmium remediation in soil include 10 families of plants such as cruciferae, Compositae, Pokeweed, Solanaceae. Phytoremediation is a green and environmentally friendly repair technology that can effectively reduce or avoid secondary pollution. In addition, phytoremediation can have a certain beautification effect on the polluted environment, and metal cadmium can be re-refined in the post-treatment of plants to achieve secondary utilization of cadmium. However, this repair method has a long repair cycle due to the growth cycle of the plant itself, and the plant growth area is also restricted, which is harsh on natural conditions and human conditions.

3.3.2. Microbial Remediation Technology

Microorganisms in some soils absorb, precipitate, and accumulate cadmium through extracellular adsorption, extracellular precipitation, and intracellular accumulation, effectively changing the presence of cadmium in soil [7]. Effectively reduce the mobility and toxicity of contaminated cadmium by utilizing the special properties of microorganisms. At present, microorganisms that have better effects on cadmium-contaminated soil restoration include bacteria (such as Bacillus, Citrobacter, Pseudomonas, etc.), fungi (such as Penicillium, Rhizopus, Trichoderma, etc.) and some small algae (Chlorella, Sargassum, etc.).

3.3.3. Animal Repair Technology

The animal repair technology is to use some low-grade animals (such as cockroaches and rodents) that can absorb the characteristics of heavy metals in the soil, to reduce the content of heavy metals in the contaminated soil to a certain extent, and to achieve the purpose of repairing heavy metal contaminated soil [8] [9] [10] [11]. At present, the repair of cadmium-contaminated soil is mainly carried out by using hydrazine. As the main group in soil animals, alfalfa can loosen the soil, promote the degradation of organic matter and waste residue in the soil, and improve the chemical composition and physical structure of the soil to improve the contaminated soil. On the other hand, it can be digested by body surface or digestion, enrichment of cadmium in the body, thereby improving the

soil environment to a certain extent. Very few animals that can tolerate and enrich cadmium used in this method are rarely used.

4. Conclusion

At present, the repair and treatment of cadmium-contaminated soil are still a hotspot and a difficult point in the field of environmental research. A variety of cadmium pollution repair methods have been developed at home and abroad, and some progress has been made. However, the repair technology still has limitations. The single repair technology cannot fully achieve the expected repair effect. In the future, it should focus on the development of scientific, efficient and comprehensive cadmium pollution repair technology, and further promote it to other heavy metal soil pollution repair and treatment work.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Yang, R.X., Luo, C.L., Zhang, G., Li, X.D. and Shen, Z.G. (2012) Extraction of Heavy Metals from E-Waste Contaminated Soils Using EDDS. *Journal of Environmental Sciences*, **24**, 1985-1994. https://doi.org/10.1016/S1001-0742(11)61036-X

[2] Zhao, N., Cui, Y.S., Fu, Y., *et al.* (2011) Leaching of Cd and Pb from a Contaminated Soil with EDTA and EDDS: Effectiveness and Health Risk Assessment. *Modern Agricultural Science and Technology*, **30**, 958-963.

[3] Tessier, A., Campbell, P.G.C. and Bisson, M. (1979) Sequential Extraction Procedure for the Speciation of Particulate Trace Metals. *Analytical Chemistry*, **51**, 844-850. https://doi.org/10.1021/ac50043a017

[4] Hong, K.J., Tokunaga, S. and Kajiuchi, T. (2002) Evaluation of Remediation Process with Plant-Derived Biosurfactant for Recovery of Heavy Metals from Contaminated Soils. *Chemosphere*, **49**, 379-387. https://doi.org/10.1016/S0045-6535(02)00321-1

[5] Monika, A., Kedziorek, M., Alain, C. and Bourg, M. (2000) Solubilization of Lead and Cadmium during the Percolation of EDTA through a Soil Polluted by Smelting Activities. *Journal of Contaminant Hydrology*, **40**, 381-392. https://doi.org/10.1016/S0169-7722(99)00056-X

[6] Diels, L., van der Lelie, N. and Bastiaens, L. (2002) New Developments in Treatment of Heavy Metal Contaminated Soils. *Reviews in Environmental Science and Biotechnology*, **1**, 75-82. https://doi.org/10.1023/A:1015188708612

[7] Matei, N., Popescu, A., Radu, G.L., Artem, V. and Pavalache, G. (2015) Cadmium and Lead Occurrence in Soil and Grape from Murfatlar Vineyard. *Ovidius University Annals of Chemistry*, **26**, 37-40. https://doi.org/10.1515/auoc-2015-0007

[8] Zhang, T., Zou, H., Wang, Y., *et al.* (2013) Experimental Study on Enhancement Technology for Electrokinetic Remediation of Lead Contaminated Soil. *Chinese Journal of Environmental Engineering*, **7**, 3619-3623.

[9] Yeung, A.T. and Hsu, C. (2005) Electrokinetic Remediation of Cadmium Contaminated Clay. *Journal of Environmental Engineering*, **2**, 298-304.

https://doi.org/10.1061/(ASCE)0733-9372(2005)131:2(298)

[10] Minguzzi, C. and Vergnano, O. (1948) Il contenuto di nichelnelleceneri di Alyssum bertolonii. *Attidella Società Toscana di Scienze Naturale*, **55**, 49-74.

[11] Rascio, N. (1977) Metal Accumulation by Some Plants Growing on Zinc-Mine Deposits. *Oikos*, **29**, 250. https://doi.org/10.2307/3543610