ISSN: 2414-1895 DOI: 10.6919/ICJE.202312_9(12).0042

A Review of Treatment Technologies for Heavy Metal Contaminated Sites

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Abstract

At present, heavy metal pollution in soil and groundwater at industrial sites is becoming increasingly serious, which has serious consequences for food safety and drinking water,water security, regional ecological environment, human settlement health, sustainable economic and social development and even social stability pose serious threats and challenges, which urgently require great attention and attention. This article combines the development status of the environmental remediation industry with a review of domestic and foreign literature, and uses the geochemical behavior characteristics of heavy metals as a background to deeply elaborate on the risk assessment technology of heavy metal contaminated soil and groundwater, and systematically sort out the principles, research progress, advantages and disadvantages of related remediation technologies. In order to provide reference for the healthy development of my country's heavy metal contaminated site remediation technology industry.

Keywords

Heavy Metal; Contaminated Sites; Soil.

1. Introduction

Entering the 21st century, my country's economic level continues to improve. With the increase in various production and living activities, the degree of soil pollution has become more and more serious. According to statistics, the area of heavy metal-contaminated soil in my country is as high as 20 million hectares. The ecological environment and ecosystems in some areas of our country have been severely damaged, and the market for heavy metal pollution control is huge. Heavy metal soil pollution in my country is in its infancy and is constantly being improved and explored. At present, my country's relatively mature heavy metal soil pollution remediation technologies mainly include in-situ/ex-situ solidification/stabilization, in-situ/ex-situ redox, and phytoremediation technologies. With the adjustment of the domestic economic structure, the traditional construction industry has been impacted, emerging business markets have developed, and many companies are targeting the heavy metal pollution control industry. How to achieve breakthroughs in technology or market share in this industry is a hot topic for many companies. This study mainly introduces heavy metal pollution

 Volume 9 Issue 12, 2023
DOI: 10.6919/ICJE.202312_9(12).0042

control technology, with a view to providing reference and suggestions for enterprises to develop the heavy metal pollution control market.

2. In-situ Remediation Technology for Heavy Metal Contaminated Soil

At present, there are two main ways to remediate heavy metal pollution in soil. The first is to change the existence state of heavy metals in the soil and reduce their mobility and bioavailability in the environment. The main remediation technologies include immobilization/stabilization technology and vitrification technology; the second is to use biological or engineering technology methods to remove heavy metals from the soil. To remove heavy metals from soil, the main remediation technologies include soil leaching/extraction technology, electric remediation technology, and thermal desorption technology.

2.1 Soil Solidification/Stabilization Technology

Soil solidification/stabilization technology refers to a remediation technology that uses physical or chemical methods to fix or transform soil pollutants into chemically inactive forms, preventing them from migrating and spreading in the environment, thereby reducing their toxicity. The key to heavy metal solidification/stabilization is to select appropriate solidification/stabilization materials. Commonly used immobilization materials include: inorganic binding substances (such as cement, lime, etc.), organic binders (such as asphalt and other thermoplastic materials), thermal hardening Organic polymers (such as urea, phenolic plastics and epoxy, etc.), among which inorganic binding substances cement and lime are the most widely used. The hydration process of cement solidified heavy metals can produce adsorption, passivation and ion exchange effects on heavy metals, allowing them to stay on the surface of the hydrated silicate colloid of cement in the form of hydroxide precipitation or complexes [1] ; The immobilization of heavy metals in soil by lime mainly increases soil pH and causes heavy metals to precipitate.

2.2 Soil Leaching/Extraction Technology

Soil leaching is the process of leaching contaminated soil with an eluent and transferring heavy metals from the solid phase of the soil to the liquid phase of the soil. The key to soil leaching technology is the selection of eluting agents. The ideal eluting agent can extract various forms of heavy metals without damaging the soil structure. There are many leaching agents for contaminated soil, mainly divided into the following categories: acid (citric acid, sulfuric acid, hydrochloric acid, nitric acid, phosphoric acid or carbonic acid), alkali (such as NaOH), salt (such as potassium dihydrogen phosphate), chelating agent (such as EDTA) or complexing agents, reducing agents and surfactants, etc. There are great differences in the eluting agents suitable for different heavy metal-contaminated soils. For the general heavy metals lead and chromium, the eluting agents currently studied mainly include water, citric acid, tartaric acid, EDTA, EDDS, NTA, SDS etc. Studies have shown that the leaching removal ability of chromium and lead in contaminated soil is EDTA>NTA>SDS>HCl [2]. EDTA can form stable complexes with most metals over a wide pH range, but for arsenic and mercury, EDTA is not the best choice, mainly due to their own properties.

2.3 Electric Repair Technology

Electric remediation refers to inserting electrode pairs into contaminated soil, and applying direct current to cause the pollutants to undergo processes such as electromigration, electroosmosis, and electrophoresis under the action of the electric field, so that they are concentrated near the electrodes and then concentrated for treatment, thereby achieving the cleaning of contaminated soil. technology. Study sheet for on-site remediation of lead contaminated soil.

It has been shown that after about one and a half months of repair, the lead removal rate can reach 70%[3]. For chromium, arsenic and mercury, the electrokinetic process is accompanied by redox processes in addition to the behavior of heavy metals [4].

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2.4 Thermal Desorption Technology

Thermal desorption technology uses direct or indirect methods to heat heavy metal-contaminated soil, desorb volatile heavy metals such as mercury and arsenic from the soil, and collect the volatile products for centralized treatment, thereby achieving the purpose of removing heavy metals from the soil. The most common application of thermal desorption technology is the remediation of mercury-contaminated soil, which is mainly based on the volatile characteristics of mercury. Research shows that the suitable thermal desorption temperature for mercury-contaminated soil is 300°C-700°C. Using thermal desorption technology, the mercury removal rate can reach more than 96% [5]. In order to reduce the energy consumption of thermal desorption technology in the process of heating soil, it can be adopted.

Using natural solar energy to thermally desorb mercury and arsenic in contaminated soil solves the problem of pyrolysis energy consumption [6].

3. Conclusion

The redevelopment of urban contaminated sites (brownfields) is one of the major environmental challenges faced by my country in the process of economic development. We must build a scientific and effective ecological civilization system and improve the environmental management framework system of contaminated sites, especially the risk-based sustainable restoration framework system. , not only lays a good institutional foundation for solving major resource and environmental problems including heavy metal pollution, but also promotes the healthy development of the environmental restoration industry.

Acknowledgments

Funding: The project of Shaanxi Province Land Engineering Construction Group(Project No.:DJTD2023-02).

References

[1] Chen Q Y, Tyrer M and Hills C D et al. Immobilization of heavy metal in cement-based solidification /stabilization: a review. Waste Management, 2009, 29: 390-403.

[2] Pichtel J and Pichtel T M. Comparison of solvents for ex-situ removal of chromium and lead from contaminated soil. Environment Engineering and Science, 1997, 14(2):97-104.

[3] Lageman R. Electroreclamation application in the Netherlands. Environmental Science & Technology, 1993, 27(13):2648-2650.

[4] Reddy K R and Chinthamreddy S. Electrokinetic remediation of heavy metals from soils under reducing environments. Waste Management, 1999, 19: 269-282.

[5] Chang T and Yen J. On-site mercury-contaminated soils remediation by using thermal desorption technology. Journal of Hazardous Materials, 2006, 128(2-3):208-217.

[6] Navarro A, Canadas I and Martinez D et al. Application of solar thermal desorption to remediation of mercury-contaminated soils. Soil Energy, 2009, 83(8):1405-1414.