Research on Leaching Rehabilitation of Heavy metal Contaminated Soil

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Abstract. With the development of heavy industry, the problem of soil contaminated by heavy metals has become increasingly prominent. Therefore, it is of great significance to find an efficient method to treat soil contaminated by heavy metals. Soil leaching technology is a common technology to remediate contaminated soil by chemical principles. The specific operation is to inject chemical solvents, such as inorganic eluents, complexing agents and surfactants, which can promote the dissolution or migration of soil pollutants into the contaminated soil, so as to dissolve, separate and treat the pollutants from the soil. It has the advantages of good repair effect and short repair cycle, and has attracted wide attention. In this paper, the sources of heavy metal contaminated soil, the existing soil remediation technology, and the research progress of heavy metal contaminated soil leaching remediation technology are discussed. It is hoped that this paper can provide reference for the remediation of heavy metal contaminated soil.

1. Introduction
With the rapid development of social economy, human beings have carried out many inappropriate industrial and agricultural activities, resulting in excessive heavy metal content in soil, and the problem of heavy metal pollution in soil has become increasingly prominent. It is reported that about 20 million hectares of cultivated land in China are polluted by heavy metals such as cadmium and lead. The grain output is reduced by 1 billion tons per year due to heavy metal pollution, and the economic losses are more than 20 billion yuan [1]. The main heavy metals involved are Hg, Cd, Pb, Cr, As, Zn, Cu, Ni and other elements [2]. For example, excessive Cd can inhibit the activity of protochlorophyll ester reductase, resulting in photosynthesis disorders and even death of plants. Heavy metals accumulated in plants may also enter the human body through the food chain, thereby damaging the human nervous system, immune system, skeletal system, etc.[3]. If the human body accumulates excessive Cd, it will cause great damage to the kidney[4]. Therefore, how to effectively control soil heavy metals is imminent.

As one of the more practical methods in remediation technology, soil leaching method is widely used because of its advantages of less investment, simple operation and quick effect. It mainly combines with pollutants in soil through eluent or assistant, and then desorbs, chelates or dissolves pollutants[5]. The commonly used eluents are inorganic acid, organic acid, artificial chelating agent and surfactant, among which EDTA is one of the most commonly used eluents because of its low acidity, good repair effect, less damage to soil and easy recovery[6]. Xue Lamei et al. [7]studied the enhancement of elution efficiency under external conditions. However, the leaching technology
requires strict soil texture. At present, high-efficiency leaching agents are expensive in the market, and the treatment of waste eluent needs to be studied[8].

2. Sources of soil contaminated by heavy metals

2.1. Pollution from Industrial Activities
Industrial activities are one of the main sources of heavy metal pollution in soil. Shi Yanli et al. [2] believe that the industrial sources of heavy metal pollution in soil come from mineral mining and metallurgy industry, IT product manufacturing, chemical industry, leather production, coal-fired power generation waste tailings in rain leaching and natural weathering process. Among them, the main source is the waste liquid and slag brought by the production activities such as industrial and mining. Zhang Lianke et al. [9] studied the soil around the aluminium plant and found that the sources of Cu, Zn, Cr and Mn were affected by the industrial activities of the aluminium plant and its surrounding areas. Dai Bin et al. [10] showed that As and Hg in soil originated from iron and steel smelting and coal combustion. The study of Jia Zhaoheng et al. [11] shows that the accumulation and pollution of heavy metals Mn, Cu, Pb, Zn and Cd in the soil of the study area are caused by mineral exploitation.

2.2. Pollution from Agricultural Activities
Wang Na[12] believes that the sources of heavy metals in farmland soils include atmospheric deposition of heavy metals, application of pesticide and chemical fertilizers in farmland, irrigation of farmland sewage, introduction of organic fertilizers and sludge fertilizers. Organic fertilizer is a high-quality farmland nutrient fertilizer that provides a large amount of essential trace elements for crop growth. At the same time, however, it also brings heavy metal elements to varying degrees. Therefore, long-term use of chemical fertilizers will reduce soil organic matter and other nutrients, and also pollute the farmland ecological environment. Therefore, excessive pesticides, fertilizers and sewage irrigation, sludge fertilization and organic fertilizer caused by agricultural production increase the content of heavy metals in soil year by year, and even cause food and health safety.

3. Soil remediation technology
Liao qiang and liu aiju believe that the remediation methods of heavy metal contaminated soil include physical/chemical remediation, bioremediation and combined remediation[13].

3.1 Physicochemical Repair
Physicochemical remediation refers to the improvement and remediation of soil using traditional physical/chemical methods, including electric remediation, electrothermal remediation, soil leaching and stable solidification. As one of the more practical methods of remediation, soil leaching has the advantages of low investment, simple operation and quick effect, which will be described in detail in the following paragraphs.

3.2 Bioremediation
Bioremediation refers to the process in which organisms completely decompose the toxic and harmful substances in the environment into carbon dioxide and water or convert them into non-toxic intermediates through life metabolic activities[14]. Therefore, it has become an important method to repair heavy metal contaminated soil. Common bioremediation methods include phytoremediation, animal remediation and microbial remediation. The main repair mechanisms for microbial remediation techniques are biosorption and biotransformation. The absorption, precipitation, fixation and covalent conversion of heavy metal ions in the soil by microorganisms, the conversion of heavy metal ions into low-toxic products, thereby reducing the toxicity of heavy metals in the environment[15].
3.3 Combined repair
Combined with two or more of these methods, heavy metals in soil can be remediation and treatment. Wang yingli[16] showed that iron-bearing rhizosphere bacteria can promote the accumulation of heavy metals in plants to a certain extent. Zhou jianming et al.[17] found that indoleacetic acid (3-indoleacetic acid) can alleviate the plant toxicity of heavy metal/chelating agent, promote plant root elongation, increase plant biomass, and coordinate chelating agent to promote the absorption, transport and accumulation of heavy metal in plants, significantly improving the extraction efficiency of plants. The experimental results of cui hongbiao et al.[18] showed that the available state content of Cu/Cd in soil decreased significantly with the addition of apatite and lime, and that high-dose lime was more effective in transferring heavy metals from soil through giant fungus grass.

4. Leaching repair technology
Soil leaching technology is a kind of using chemical principle to repair the common technology of contaminated soil, the specific operation is to shift can promote the dissolution of soil pollutants or chemical solvents, such as inorganic drench lotion, complexing agent and surfactant into the contaminated soil, so as to dissolve contaminants from the soil, isolated and processing. The mechanism of soil leaching is to use eluents or chemical AIDS to combine with pollutants in the soil, and through the desorption, chelation, dissolution or fixation of eluents, so as to achieve the purpose of repairing contaminated soil. According to the location of treated soil, soil elution can be divided into in-situ soil elution and heterotopic soil elution[19].

4.1 In Situ Soil Leaching
In situ soil leaching technology requires the establishment of repair facilities in situ, so it is called in situ leaching, and includes the construction of cleaning fluid feeding system, soil subsoil leachate collection system and leachate treatment system. It refers to the application of leaching agent to the soil through injection Wells, etc., so that it penetrates downward, passes through the pollution zone and combines with the pollutant, and finally forms the transportable compound through desorption, dissolution or complexation. Solutions containing contaminants can be collected, stored, and further treated by means of extraction Wells so that they can be used again for the treatment of contaminated soil. At the same time, it is necessary to seal off contaminated areas, usually using physical barriers or segmentation techniques. This technique is mainly used to treat heavy metals in porous, homogeneous and permeable soils, organic compounds with low octane/water distribution coefficient, hydroxyl compounds, alcohols and hydroxyl acids with low molecular weight. Its advantages include: no need to dig and transport contaminated soil; It is suitable for removing many kinds of pollutants in vadose zone and saturated zone. Suitable for combination process. Disadvantages: it may pollute the groundwater in the treatment site; The removal effect and the duration of repair could not be predicted properly. The removal effect is subject to the geological conditions of the site.

4.2 Heterotopic Soil Leaching
As the name suggests, heterotopic soil leaching involves digging up contaminated soil, sifting it out of its oversized components, separating the soil into coarse and fine materials, washing and removing the contaminants with an eluent, then treating the leaching solution containing the contaminants, and backfilling or transporting the clean soil to another site. The core of this technique is the mechanical suspension or agitation of soil particles through hydraulics. The minimum size of soil particles is 9.5mm, and gravel and particles larger than this size can be easily washed away from the soil by this method. Ectopic soil leaching is often used as a pretreatment to reduce the amount of contaminated soil, mainly in combination with other remediation techniques. When sand and gravel content in contaminated soil exceeds 50%, ectopic soil leaching becomes more effective. However, for contaminated soil with clay and powder content of more than 30%~50%, or with high humus content, the separation and removal effect of ectopic soil leaching technology is poor. General technical processes of ectopic soil leaching and remediation are :(1) excavation of contaminated soil. (2) sieve
soil components, remove debris and remove gravel with excessive grain size. (3) leaching treatment: the contaminated soil was mixed with the eluent at a certain ratio of soil to liquid. After the soil pollutants were extracted by the eluent, they were allowed to stand for solid-liquid separation. (4) elution waste solution treatment. After the elution waste solution containing suspended particles is treated, the sludge generated can be eluted or sent to the final disposal site for treatment after dehydration. So that it can be used again for leaching. (5) discharge of volatile gas after reaching the standard. (6) backfill or safe use of the soil after leaching meets the control standards.

### 4.3 Problems and Prospects

Due to the use of artificially added chemical and biological substances in the leaching and remediation process, soil quality and soil microbial content may be affected to some extent. After soil leaching and remediation, proper agronomic measures should be adopted to speed up the restoration of soil quality. Artificial complexing agent can achieve a higher leaching efficiency, but these chemicals are difficult to biodegrade and may migrate to the ground and contaminate groundwater. Therefore, it is necessary to screen non-toxic or less toxic leaching agents, which are easy to biodegrade, to improve the acceptability of leaching repair technology. As a pretreatment step of pollution control, leaching remediation technology has broad application prospects. At present, the problems and research directions that are widely concerned include: how to recycle and utilize chemical additives from leachate; How to reduce the cost of chemical additives and realize the effective combination of soil leaching and other remediation technologies.

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