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Research Progress of Heavy Metal Contaminated Soil Remediation Technology

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Abstract

The development of industrialization, the progress of agriculture and human production activities have caused serious soil heavy metal pollution problems. Heavy metal pollution in soil is highly concealed and easy to accumulate. It will be absorbed by the human body through the food chain and food web, threatening food safety and human health. Therefore, the author starts from the harm and source of heavy metal pollution in soil by consulting a large number of documents. The progress of phytoremediation technology, animal remediation technology, biochar remediation technology and organic stable material remediation technology in soil heavy metal pollution control was reviewed. Based on the current status of technology, the best remediation technologies and prospects for soil heavy metal pollution in the future are prospected, in order to provide reference for the prevention and remediation of soil heavy metal pollution in my country.

Keywords

Heavy Metal Pollution; Pollution Source; Remediation Technology; Prospect Analysis.

1. Introduction

Soil is a place for animal and plant activities and material exchange of microorganisms, and is an important part of the ecosystem.With the advancement of industrialization and urbanization, human activities have had a significant impact on changes in soil quality [1]. With the development of mineral resources, the overuse of pesticides and fertilizers, the discharge of industrial waste gas and wastewater, and the smelting of metal ores, soil heavy metal pollution has become increasingly serious [2]. Heavy metals refer to metals with a density greater than 4.5 g/cm^3, including cadmium, chromium, copper, nickel, lead, zinc and other elements. Different from other organic pollutants, heavy metals are not easy to be detected, have certain concealment and latency, and can only be degraded by microorganisms or chemical pathways in the soil, resulting in long-term preservation and accumulation in the soil [3]. Once the heavy metal content exceeds the standard limit, it may not only cause soil function degradation, but also be absorbed by the human body through bioaccumulation, posing a huge threat to food safety and human health [4]. The soil itself has a certain self-purification ability and anti-erosion ability, but once the pollutants entering the soil exceed the critical value of the soil bearing capacity, it will cause serious soil pollution [5]. The prevention and restoration of heavy

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metal pollution in soil has become an important work to be carried out for a long time in the future. In order to effectively remediate heavy metal-contaminated soils, a variety of physical, chemical, and bioremediation methods have been proposed in the past few decades. These methods may reduce the total concentration of pollutants, or reduce their bioavailability, or curb the spread of heavy metal pollutants, thereby achieving environmental improvement. In practical applications, the scope of application, efficiency and cost of these repair methods have their own advantages and disadvantages. Therefore, it is necessary to make a comprehensive comparison of these remediation technologies in order to make a reasonable assessment of their applicability, development status and prospects, and to provide a certain reference for the selection of heavy metal remediation technologies and environmental improvement according to local conditions.

2. Sources of Heavy Metals in Soil

2.1. Industrial Pollution

The three industrial wastes refer to "wastewater, waste gas and waste residue"[6]. With the continuous acceleration of industrialization and the development of urbanization, more and more three wastes are generated in the production process of industrial enterprises, and most of these three wastes contain harmful and toxic heavy metals. If they are not properly handled, they will penetrate Into the soil, it will cause various pollution and damage to the surrounding soil environment, which not only affects the soil quality, but also leads to a decline in the yield of various plants and crops. During the mining and smelting process of mines, resource mining, ore accumulation, and tailings treatment will generate a large amount of waste, and these wastes often contain a large amount of toxic and harmful heavy metals. The unreasonable manual disposal of these wastes can easily lead to the leakage and release of heavy metals, causing serious pollution and damage to the surrounding soil, air, and water resources.

2.2. Agricultural Pollution

The soil pollution caused by agricultural activities mainly includes sewage irrigation and the unreasonable use of pesticides, fertilizers and plastic films. The sewage in many cities is used to irrigate farmland without strict and scientific treatment, resulting in the infiltration of heavy metal elements into the soil and gradual accumulation. In addition, the improper use of chemical fertilizers, pesticides, plastic films, etc. in agricultural production can also cause heavy metal pollution in the soil [7]. For example, cadmium and lead are usually added as heat stabilizers in the production process of plastic films. Unreasonable use will lead to the accumulation of heavy metals in the soil. , causing serious soil pollution and threatening food security.

2.3. Atmospheric Deposition

In the process of industrial and agricultural production, many gases and dusts containing heavy metals will accumulate in the air, and these toxic and harmful heavy metals will settle into the soil along with the rainfall process, thus causing different degrees of pollution and damage to the soil. In addition, with the continuous development of the automobile industry, the phenomenon of vehicle exhaust exceeding the standard is becoming more and more serious [6]. These excessive exhaust gases contain a large amount of heavy metals. With the continuous discharge of the exhaust, the toxic and harmful heavy metals will gradually settle into the soil, eventually polluting and destroying soil environment [8].

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3. Soil Heavy Metal Remediation Technology

3.1. Phytoremediation Technology

Phytoremediation is the use of hyperaccumulators to fix, transform or root filtrate heavy metal-contaminated soil to reduce the heavy metal content in the soil [9]. Phytoremediation has the advantages of good economic benefits and environmental protection. Guo et al. [10] studied the effect of jute plants on the restoration of heavy metal Cd in farmland and found that jute has a good enrichment effect on Cd, and the Cd content that can be enriched per hectare of jute can reach 53.3 g, and the adsorption effect of jute wood on Cd The most significant, up to 33.11% of the total adsorption 42.99%. However, phytoremediation also has many defects.The use of phytoremediation technology to alleviate soil heavy metal pollution is a relatively slow process and requires a long period of time. Moreover, in the process of growing, refining, and harvesting, with the continuous increase of the number of times, the improvement and treatment effect on the soil will become lower and lower, and many plants with extraction and restoration are relatively short, and the speed of restoration will also be reduced. produce various effects, which lead to the gradual inefficiency of the use of phytoremediation technology.

3.2. Animal Restoration Technology

Earthworms have a good remediation effect on soil organic matter and heavy metal pollution.

The adsorption, accumulation and elimination of earthworms on pollutants are complex and related to many factors [11]. The earthworm repair process includes the absorption, transformation and degradation of pollutants, and the mechanisms involved are divided into internal and external mechanisms. The internal mechanisms include improving soil physical and chemical properties, stimulating soil microbial growth, affecting microbial activity and metabolism, and improving plant absorption. The external mechanisms include the physiological activities of earthworms, and the effects of earthworms on the form, migration and biological availability of pollutants [12].

3.3. Biochar Remediation Technology

Clay minerals have a good ability to adsorb heavy metals. Many studies have combined clay minerals and biochar into the treatment of heavy metal pollution in soil. The two have better remediation capabilities for lead and cadmium composite pollution, and a single clay mineral material can be better. Lead-contaminated soil can be treated locally, and a single biochar material is stronger in remediation of cadmium-contaminated soil. In addition to the composite treatment of different materials and biochar, the combination of two or more types of biochar can also have a good effect on the restoration of lead in soil. Biochar is modified by different technologies in order to enhance its remediation ability. Using straw biochar and iron flocs generated from acid mine wastewater as raw materials, chemical modification and UV radiation combined technology are used to jointly produce modified biochar , and then use the orthogonal test to determine the optimal modification conditions [13].

3.4. Organic Stabilized Repair Agent

At present, the commonly used organic remediation agents include organic fertilizer, livestock manure and municipal sludge. Organic matter in organic compost can improve the physical and chemical properties of soil, provide nutrients for plant growth, promote its growth and development, and can effectively reduce the mobility of heavy metals in soil. For example, compost can promote the growth of ryegrass and reduce Cd and Pb content in its body [14]. However, since organic fertilizers contain heavy metals, a large amount of organic fertilizers will aggravate heavy metal pollution to a certain extent. Therefore, risk assessment and follow-up work should be carried out before applying organic substances to remediate contaminated soil.

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4. Summary and Prospect

The continuous advancement of the industrialization process and the continuous influence of human production activities have caused serious soil heavy metal pollution problems. Because heavy metal pollutants have the characteristics of high concealment, easy accumulation, difficult migration and significant harmful effects, soil heavy metal pollution is more serious than air pollution and water pollution. The organic-stabilized material remediation method has the advantages of being environmentally friendly, safe, and cost-effective, but it is time-consuming and effective only for low to moderate levels of heavy metal pollution. Earthworm's own life activities and intestinal functional microorganisms can jointly promote the degradation and transformation of exogenous pollutants, and have great development potential. In addition, biochar can be modified to improve its performance, and at the same time, it also has excellent performance in soil pollution remediation when combined with other remediation methods such as plant overabsorption and microbial decomposition. Compared with other technologies, phytoremediation has higher environmental benefits and public acceptance, and it is suitable for large areas of low-polluted soil. The main obstacle to the practical application of this technology is the long time required for restoration.

In order to effectively remediate heavy metal-contaminated soil without affecting the normal utilization of the remediated soil, the concepts of ecological restoration and sustainable utilization should be added to soil restoration. Combined restoration techniques are used, but these restoration methods should strike a balance between being environmentally friendly, affordable, and acceptable to the public. Through a comprehensive evaluation of the existing soil remediation technologies, the combined remediation method of biochar and amendment is the most sustainable and promising remediation technology. However, for the research and development and practical application of materials, it is necessary to increase research and development efforts in the future.

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