Summary of Current Status and Repair Techniques of Heavy Metal Pollution in Soil

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Abstract

With the development of modern agriculture and industrial society, the rapid development of science and technology, more and more serious. The soil heavy metal pollution of soil heavy metal pollution refers to the content of heavy metals in soil accumulation exceed the standard the pollution caused by the heavy metals pollution, mainly includes: Cd, Pb, Hg, Cr, As, Cu, Zn, Ni and so on. Because of the soil heavy metal pollution has the function of large range, long duration, concealment, refractory and other characteristics, so as to soil quality, crop physiological and biochemical function, causing adverse effects of groundwater and ecological environment, and ultimately threaten human health. Therefore, the research and practice of soil heavy metal pollution Complex technology is of great significance to human society. The heavy metal pollution in soil at home and abroad found that the settlement of soil heavy metal pollution mainly comes from air pollutants, sewage irrigation, agricultural materials and application of solid waste piled up. This paper reviewed the heavy metal contaminated soil remediation technology (physical remediation, chemical remediation, bioremediation, agricultural ecological restoration and remediation Research) progress, and for a variety of repair methods, expounds the principle, application and repair conditions, advantages and disadvantages. Finally, on the basis of existing research, the combined remediation technology (such as joint biotechnology, the combination of physical and chemical technology and physical chemical biological technology can be combined) In order to overcome the shortcomings of using a single repair method to a certain extent, it can improve the recovery efficiency of composite pollution and reduce the repair cost. In the future, we should explore the interaction mechanism of joint repair technology in the future. In order to provide scientific basis for comprehensive treatment and pollution remediation of heavy metals in soil..

Keywords

Soil, heavy metal, pollution, remediation technology.

1. Status of Heavy Metal Pollution in Soil

Heavy metal pollution is one of the most notable global environmental pollution problems today. The situation of heavy metal pollution in China is also very serious. According to the survey results, soil pollution is mainly caused by industrial and mining and agricultural production. The Ministry of Agriculture's environmental monitoring system has investigated the soils of 24 provinces, municipalities and 320 heavily polluted areas in the country. The over-standard area of farmland agricultural products accounted for 20% of the farmland area in the polluted areas, and the heavy metals exceeded 80% of the contaminated soil and crops. According to statistics, the world's average annual emission of Hg is about 15,000 tons, Cu is about 3.4 million tons, Pb is about 5 million tons, Mn is about 15 million tons, and Ni is about 1 million tons. Among them, Hg and Cd have the largest pollution area. About 1.3×104hm2 of cultivated land is currently polluted by Cd in the country, involving 25 regions in 11 provinces and cities; about 3.2×104hm2 of cultivated land is contaminated by Hg, involving 21 regions in 15 provinces and cities[1].

China's land is vast, but agricultural land is relatively tight. In the current work of ecological civilization construction, the protection of cultivated land is of great significance. In 2016, the No. 1 Document of the Central Committee emphasized that “the development of green agriculture is the concept of protecting the ecology and accelerating the governance of outstanding problems in the agricultural environment”[2], which points the way for the development of ecological agriculture in China in the future. In recent decades, with the large-scale development and utilization of China's mineral resources and the rapid development of industry and agriculture, a large amount of heavy metal materials are discharged into farmland soil, which leads to heavy metal pollution in soil. According to reports, China's annual grain production reduction due to heavy metal pollution reached 10 million tons, and the grain contaminated by heavy metals reached 12 million tons, resulting in economic losses of more than 20 billion yuan[3]. Therefore, the repair of soil contaminated by heavy metals is a key task in the construction of ecological agriculture in China.

2. Source of Heavy Metal Pollution in Soil

Heavy metal pollutants are characterized by high toxicity, refractory degradation and accumulation in living organisms, and pose a great threat to human health and the ecological environment. Scholars at home and abroad have conducted more research in the field of heavy metal pollution, and pollution sources and repair techniques have always been research hotspots. Atmospheric deposition of pollutants, solid waste dumping, sewage irrigation and agricultural material application are the main sources of heavy metal pollution in the soil.

2.1 Atmospheric Deposition

A large amount of dust and toxic and harmful gases generated in industrial production will enter the soil through natural sedimentation process and precipitation circulation system, causing heavy metal pollution. Atmospheric deposition of pollutants is an important way to contaminate soil heavy metals. According to statistics, the annual heavy metals Pb, As, Cd and Zn entering the soil through atmospheric deposition in Belgium are 250g, 15g, 19g and 3750g, respectively[4]. Cu, Ni, Pb and Sb in farmland topsoil in the province of Cordoba, Argentina, are mainly derived from the settlement of atmospheric pollutants in local industries and traffic[5]. The content of 11 heavy metals in different types of atmospheric PM10 particles in Fushun City was analyzed. It was found that Co, Ni, Cu, Zn and Pb were 291, 312, 56, 135 and 39 times of soil background values, respectively. Correlation and principal component analysis. It indicates that motor vehicle emissions, industrial activities and coal combustion are the main sources of heavy metal pollution in the atmosphere[6]. Another important source of heavy metal pollution in soil is atmospheric pollution caused by mining and heavy metal smelting. A study on heavy metals in dry soil near an electroplating plant in Changshu found that the combined pollution of Zn and Ni gradually decreased with increasing distance. The degree of Zn pollution is increasing year by year[7]. Heavy metal pollution in the soils of cities such as Beijing, Shanghai and Xi'an may be mainly caused by traffic[8].

2.2 Solid Waste Stacking and Disposal

Heavy metals in solid waste are highly mobile and diffuse into the surrounding soil and water bodies in the form of radiation or pores. Solid waste generated by industrial production can be easily piled up without treatment, which can easily cause heavy metal pollution in the surrounding farmland and cultivated land. The slag containing Zn and Cd in Shenyang smelter has been stacked in open space for a long time and has not been treated centrally. At present, the pollution has spread to the surrounding 700m.

2.3 Sewage Irrigation

Sewage irrigation, using urban industrial wastewater and domestic sewage and other excess water for farmland irrigation. Through the study of farmland irrigated by long-term use of sewage in Harare, Zimbabwe, the accumulation of Cu, Zn, Pb, Cd, Ni and Cr in soil and corn crops is high, exceeding the limits of human and livestock intake[9].

The lack of water resources in China has led to the widespread use of sewage irrigation. Wastewater discharged from chemical plants and the like contains a large amount of heavy metal elements. If discharged to nature without treatment, the soil will be exposed to severe heavy metal pollution. According to statistics, the content of heavy metals such as Hg, Cr, Pb and Cd in sewage irrigation areas in China has increased year by year, and most of them have exceeded local background values and national safety labels. According to the survey conducted by the Ministry of Agriculture on the farmland in the national sewage irrigation area, heavy metal pollution accounts for 64.8% of the total area in the sewage irrigation area of about 1.4×106hm2, of which light pollution accounts for 46.7%, moderate pollution accounts for 9.7%, and serious pollution accounts for 8.4%[10].

2.4 Agricultural Substance Application

Excessive use of agricultural substances such as pesticides, fertilizers and sludge composting products can cause heavy metal pollution in farmland. The most important pollutant in fertilizer is heavy metal, and its mass fraction is generally phosphate fertilizer > compound fertilizer > potassium fertilizer > nitrogen fertilizer. Heavy metals such as Se, Cr and Cd in French farmland are mainly derived from mineral fertilizers, among which the mass fraction of Cr and Cd in phosphate fertilizer is the highest[11]. In the livestock and poultry breeding process, in addition to the use of Cu and Zn containing feed additives, sometimes with As, Cd, Cr, Pb and Hg additives[12], such as Yiwu, Xiaoshan and other places in the pig feed As quality score up to 110mg·kg-1[13], indicating that the heavy metal mass fraction in livestock manure is closely related to feed.

3. Soil Heavy Metal Pollution Repair Technology

At present, the international soil heavy metal pollution remediation technologies mainly include physical, chemical, biological, agro-ecological and joint restoration technologies.

3.1 Physical Repair Technology

3.1.1 Engineering Measures

The engineering measures mainly include land, soil replacement and deep tillage. The guest soil method refers to the effect of laying clean soil on the surface of contaminated soil or directly mixing the two soils to reduce the concentration of heavy metals in the contaminated soil. The soil replacement method refers to excavating contaminated soil and replacing or partially replacing the originally contaminated soil with uncontaminated soil. For the thick soiled soil, the deep tillage method can be used, and the heavy metal is dispersed to the bottom by deep turning to achieve the purpose of reducing the concentration of heavy gold. Deep tillage is used for lightly polluted soils, while soil and soil replacement are common methods for heavily polluted areas.

The engineering measures can completely solve the problem of soil pollution, but the operation is difficult and the cost is high, which easily leads to the destruction of the soil structure and the soil fertility decline. In order to prevent secondary pollution, centralized treatment of contaminated soil is also required. Therefore, this method is only suitable for the repair of a small area of heavily polluted soil[14].

3.1.2 Desorption and Desorption

Desorption and desorption technology can be divided into normal temperature desorption and thermal desorption, and thermal desorption is also called thermal desorption technology. For heavy metal contaminants, desorption and desorption techniques are generally used to treat volatile heavy metals such as mercury and arsenic. This technology is more used to treat volatile organic compounds and semi-volatile organic compounds.

The principle of thermal desorption technology is relatively simple. By direct or indirect heating, volatile heavy metals and organic substances in the contaminated soil are evaporated or separated, and processed by a gas collection and treatment system.

Most of the thermal desorption technologies and equipment currently used in China originate from abroad. In addition to drum-type thermal desorption technology, fluidized bed thermal desorption, far infrared thermal desorption and microwave thermal desorption technology are all emerging technologies[15]. Professor Jiang Jianguo of Tsinghua University has developed an organic-contaminated soil drum-type reverse thermal desorption system. The system has high desorption efficiency and is the first reverse thermal desorption system with independent intellectual property rights in China. The study found that the in situ thermal desorption technique has a Hg removal rate of 99.8% in the soil below the boiling point of the soil[16]. In recent years, many scholars have proposed new ideas for replacing solar energy with non-renewable energy. This idea will solve the problem of high energy consumption of thermal desorption technology. Studies have shown that solar energy has a certain degree of desorption of Hg and As in soil[17].

Compared with other repair methods, this technology has many advantages: short time, high removal rate, and recoverable heavy metals; but the disadvantages are: high energy consumption, easy to produce secondary pollution and this technology is only high in the treatment efficiency of high concentration contaminated soil.

3.2 Chemical Repair Technology

3.2.1 Electric Repair

Electric repair is to form an electric field gradient by applying a DC voltage on both sides of the contaminated soil. Heavy metal contaminants in the soil are brought to the ends of the electrode by electrodialysis, electromigration or electrophoresis under the electric field (Table 1), and then Centralized collection and treatment to clean the soil[18]. This method can control the flow direction of contaminants and is suitable for low permeability clay and silt. At present, the method has been initially applied to the design of the cell body, the electric process and its mechanism, and the establishment of the model. The soil contaminated with Pb (300~1000mg·kg-1) and Cu (500~1000mg·kg-1) was repaired on site, and the voltage of 10h·d-1 was applied for 43d, Pb and Cu in the test area of 70m×3m. The removal rates are 70% and 80%, respectively[19].

Table 1. Several main motor effects in electric repair

Motor effect	Sports substance	speed	Relationship with soil properties
Electrodialysis	Gap water	Slower	close
Electromigration	Charged ion	fast	Smaller
Electrophoresis	Colloidal particles	Slower	close

Electro-repair is an in-situ remediation technology. It is an economically viable remediation technology that removes organic pollutants and heavy metals from the soil. It has the characteristics of not agitating the soil layer, easy to operate and high processing efficiency, but the method is easy to make. The physical and chemical properties of the soil have changed. The efficiency of electric repair is reduced due to the adsorption of pollutants on the surface of the soil and the influence of H+ (positive) and OH- (negative) at both ends of the electrode[20].

With the rapid development of various enhanced electric repair techniques (such as reducing soil pH and adding enhancers), Yeung and Gu have reviewed and classified the enhancement techniques in detail[21]. Gidarakos and Giannis used 0.01mol·L-1CH3COOH or 0.01mol·L-1 citric acid as the catholyte to prevent Cd from being precipitated as Cd(OH)2. The results showed that when the pH of the catholyte was <4.0, the anode produced a large amount. H+ can desorb Cd2+ on the surface of soil particles and improve the removal efficiency [22]. Studies have shown that by changing the electrolyte conditions to enhance the electric repair effect of Cu, Pb and As contaminated soil, and using HNO3 as the catholyte, the removal ability of Cu and Pb can be improved, the maximum removal rate is 60.1% and 75.1%; The anolyte can increase the mobility of the anion form As, and the removal rate can reach 43.1%[23].

3.2.2 Leaching Technology

Soil leaching technology, also known as soil extraction technology, is to mix and rub a certain liquid that dissolves pollutants with the soil, thereby transferring the pollutants to the liquid phase and a small part of the soil, and then further processing the eluent and A small part of the soil technology.

The effect of soil leaching is affected by factors such as eluent, soil properties, heavy metal concentration and morphology. Among them, how to choose a good eluent with good heavy metal extraction and clean without secondary pollution is the key to soil leaching technology. The eluent generally includes an inorganic solution, a chelating agent, a surfactant, and the like. The following table shows the removal effects of different eluents on heavy metal contaminated soil (Table 3-2).

Table 2. Effect of different eluents on soils with different heavy metal pollution types

Eluent	Heavy metal pollution type	Repair effect
Ammonium nitrate, ammonium dihydrogen nitrate, ammonium oxalate	Zn、Pb	With the increase of the number of leaching, the concentration of zinc in the eluent decreased, and the decrease of ammonium oxalate gradually decreased with the increase of concentration; the concentration of lead in the eluent increased with the concentration of eluent and the number of leaching. . Among them, the increase in ammonium oxalate treatment is large.
EDDS	Cd、Cu、Zn、Pb	Under the condition of pH=5.5, EDDS had the highest removal rates of cadmium, copper, zinc and lead, which were 52%, 66%, 64% and 48%, respectively.
EDTA、EDDS	Cd、Pb	The highest removal rates of cadmium by EDTA and EDDS were 82% and 46%, respectively. In the range of 5~30mmol·L-1, the EDDS was higher than EDTA for lead removal at the same concentration.
Citric acid	Cr	When the amount of leaching reached 5.4 pore volumes, the total chromium removal rate of the soil was 29%, and the removal rate of the main pollutant chromium (VI) in the soil reached 51%.
TexaponN-40、Tween80、Polafix CAPB	Cu、Ni、Zn、Cd、As、	The removal rates of Texapon N-40 for copper, nickel and zinc were 83%, 82% and 86%, respectively. The removal rates of Tween80 for cadmium, zinc and copper were 86%, 85% and 81%, respectively. Polafix CAPB for nickel and zinc. The leaching rates of arsenic were 79%, 83% and 49%, respectively.
Saponin	Cu、Zn、Pb	Under acidic conditions (pH=4.0), the highest removal rates for copper, lead and zinc were 95%, 98% and 56%, respectively.

The eluent is a liquid having an action of ion exchange, chelation, and complexation. By studying the removal effects of ammonium nitrate, ammonium dihydrogen phosphate and ammonium oxalate on Zn and Pb, it was found that the concentration of Zn in the eluent decreased with the increase of the number of leaching, regardless of the concentration of the eluent. As the concentration of ammonium oxalate increased, the decrease gradually decreased; the concentration of Pb in the eluent increased with the concentration of eluent and the number of leaching. Among them, the increase in ammonium oxalate treatment is greater[24]. By studying the repair effect of ethylenediamine-N,N'-disuccinic acid (EDDS) on Cd, Cu, Zn and Pb contaminated soils, it was found that when the pH of EDDS is pH=5.5, 52% of Cd can be removed. 66% Cu, 64% Zn and 48% Pb[25]. By studying the removal of Cd and Pb by two kinds of chelating agents such as ethylenediaminetetraacetic acid (EDTA) and EDDS, it was found that EDTA and EDDS have good removal effects on Cd, and the removal rates are up to 82% and 46%, respectively. At the same concentration, EDDS had better Pb removal than EDTA[26]. The method of intermittent leaching of soil column was used to study the removal effect of citric acid on total Cr and main pollutant Cr(VI) in soil. When the amount of leaching reached 5.4 pore volume, the total Cr removal rate of soil was 29%. The removal rate of Cr(VI) is 51%[27]. The effects of three surfactants, such as Texapon N-40, Tween80 and Polafix CAPB, on the removal of Cu, Ni, Zn, Cd and As were investigated. The three surfactants have good effects on the repair of heavy metal contaminated soil[28]. To study the repair effect of saponin on Cu, Pb and Zn contaminated soils, it was found that saponin can remove 95% of Cu, 98% of Pb and 56% of Zn under acidic conditions[29].

3.2.3 Stabilization/Curing Repair Technology

Stabilized/solidified soil remediation technology is to fix harmful pollutants in the soil or convert them into chemically inactive forms, making it difficult to migrate and diffuse, thus reducing the degree of poisoning of pollutants[30]. Stabilization/curing repair technology is widely used in the repair of heavy metal contaminated sites, and can be divided into in situ technology and ectopic technology according to the treatment location.

Common curing agents include inorganic binders (such as cement, lime, etc.), organic binders (such as thermoplastics such as asphalt), thermosetting organic polymers (such as urea, phenolics and epoxides), and vitreous materials. Four categories[31]. Among them, inorganic binders such as cement and lime are the most widely used.

The mechanism of stabilization/cure technology mainly includes: (1) hydration reaction, embedding by heavy curing agent such as cement, adsorption of heavy metals or precipitation with heavy metals, redox and the like, thereby reducing the solubility, migration and toxicity of heavy metals; (2) Stabilizing heavy metals by physical adsorption, isomorphous substitution, chemical precipitation, etc. of the curing agent.

In recent years, the development of new stable/curing agents has become one of the focuses of heavy metal pollution control. Korean scholars studied the solidification effect of ladle slag and FeSO4 on heavy metals in leather peat, and concluded that FeSO4 with lime can better solidify heavy metals. MgO and various gel materials such as blast furnace cinder, fly ash, etc. are made into new curing agents, and it is found that the curing agent can greatly enhance the strength of the solidified body[32].

Compared with other repair technologies, the curing/stabilization technology has the advantages of simple operation, low cost, wide application range, increased soil strength, and good resistance to biodegradation. The disadvantage is that the depth of treatment is limited, only the presence and activity of heavy metals are changed, and there is a risk of recontamination.

3.3 Bioremediation Technology

Bioremediation refers to measures to achieve environmental purification and ecological effects recovery by using specific organisms to absorb, transform, remove or degrade environmental pollutants, including phytoremediation, animal remediation and microbial remediation. The method has the advantages of low cost, simple operation, no secondary pollution, good treatment effect and large-scale application and application. [33]

3.3.1 Phytoremediation

Phytoremediation technology refers to the general term for using plants to extract, absorb, decompose, transform and fix toxic and harmful pollutants in soil, sediment, sludge, surface water and groundwater. Phytoremediation technology can both absorb and remove contaminants as well as fix and convert contaminants in situ. Plant extraction, plant fixation and plant evaporation are all phytoremediation techniques for contaminated soil.

（1）plant extracts

Plant extraction refers to the use of hyperaccumulators to absorb heavy metals in contaminated soil and accumulate in the upper part of the plant, harvesting the aerial parts of plants to achieve the purpose of removing pollutants.

Hyperaccumulators are more capable of absorbing and enriching high levels of heavy metals from soil or water than ordinary plants, and have the characteristics of transporting heavy metals from the lower part of the plant to the upper part of the plant, showing a high enrichment factor. The key to plant extraction technology is the screening of super-enriched plants. At present, there are more than 400 species of super-enriched plants in the world. The genus Pteridium is the first super-enriched plant in the world[34]. The superior enrichment ability can improve the removal ability of As by castration. Zhang Xingfeng, from the South China Botanical Garden of the Chinese Academy of Sciences, carried out research on the potential of remediation of heavy metal contaminated soil by forage grasses. It was found that hybrid Pennisetum and Reyan 11 black seed gar is the excellent grass species for plant extraction technology. The former can repair Cd and Zn contaminated soil. Can repair Cd contaminated soil[35]. In addition, natural chelating agents such as citric acid, oxalic acid and tartaric acid can also increase the efficiency of plants in extracting heavy metals.

（2）Plant fixation

Plant fixation refers to the process of using plant roots to fix heavy metals in soil. Heavy metals are absorbed by the roots or adsorbed on the surface of the roots, and can also be fixed in the rhizosphere by root exudates. Plant fixation reduces the mobility and bioavailability of heavy metals in the soil, preventing the migration of heavy metals into groundwater and air and their transport in the food chain.

The accumulation of As, Cd and Pb in the soil was mainly in the roots, and the cumulative amount was up to 31.69, 35.12, 87.12 mg·kg-1, and only 2.06, 2.83 and 20.18 mg·kg-1 in stems and leaves. Therefore, oriental cattail can be used as one of the potential target plants for the stable restoration of As, Cd and Pb contaminated soil plants[36].

（3）Plant evaporation

Plant volatilization refers to the use of some special substances or microorganisms secreted by plant roots to convert Se, Hg, As, etc. in soil into a volatile form to remove its pollution. Plant evaporation technology is suitable for repairing soil contaminated by Se, Hg, As, etc.

The kenaf converts trivalent selenium in the soil into volatile methyl selenium for the purpose of removal. Planting tobacco can convert mercury from soil into gaseous mercury and remove mercury from the soil[37].

Phytoremediation technology can simultaneously repair contaminated soil and its surrounding polluted water, and improve soil organic matter content and soil fertility. However, this technology also has some shortcomings. For example, phytoremediation can only repair soils with moderate pollution; soil heavy metal pollution is often compound pollution, while a plant can only repair a certain heavy metal contaminated soil, and may also activate soil. Other heavy metals; super-enriched plants are short and slow to grow, and it is difficult to meet the requirements of quickly repairing contaminated soil.

3.3.2 Animal Repair

Animal remediation is the use of certain lower animals in the soil (such as cockroaches and rodents) to absorb heavy metals in the soil. The soil is absorbed or transferred to the soil by using high-enriched animals. Methods such as watering and flooding out of the soil to reduce the mass fraction of heavy metals in contaminated soils.

Through the study of cockroaches, it is found that the absorption capacity of lanthanum for heavy metals in soil is Zn>Cu>Pb>Hg. At the same time, it can also improve soil and maintain soil fertility[38]. Animal remediation technology can not deal with high concentrations of heavy metal contaminated soil. In addition to mites, other soil animals with strong remediation ability have yet to be further studied.

3.3.3 Microbial Repair

Microbial remediation is the use of active microorganisms to adsorb or convert heavy metals into low-toxic products, thereby reducing the degree of heavy metal pollution. The bacteria used for repair are mainly bacteria, fungi and actinomycetes. Studies have found that some strains isolated from the rhizosphere of the cattail can passivate Cu and Cd in the fixed soil and reduce their exchangeable content in the soil. In the experiment of removing Cr(VI) from simulated soil column by Aspergillus niger, it was found that when the soil water content is the field water holding capacity, the mass fraction of (Cr)(VI) in the soil is 250mg·kg-1, and Cr(VI) within 15d. The removal rate was 75%[39].

At present, microbial remediation is the technology with the most development potential and application prospects, but the microbial individuals are small, difficult to separate from the soil, and there are problems such as competition with indigenous strains at the restoration site. Therefore, screening high-efficiency strains, constructing strain libraries and optimizing combined repair techniques will be the main research directions in the future.

3.4 Agricultural Ecological Restoration Technology

Agro-ecological restoration mainly includes agronomic restoration and ecological restoration. Agronomic restoration is to reduce heavy metal pollution in the soil by adjusting crop varieties and selecting organic fertilizers containing less heavy metals or capable of fixing heavy metals. Ecological restoration is to control the ecological factors such as water, nutrients, Ph, temperature and humidity in the contaminated area to reduce soil. Heavy metal pollution. The technology has the advantages of low cost and less disturbance to the soil environment, but the repair cycle is long and the effect is not significant.

3.5 Joint Repair New Technology

Traditional restoration techniques have certain limitations. The method of soil and soil can not completely solve the problem and there is the risk of secondary pollution; the electric repair technology is only suitable for small-scale pollution, the actual operation is difficult and not suitable for soil with high permeability and weak conductivity; chemical repair technology is easy Destruction of the soil requires waste treatment, and the cost is high; the phytoremediation technology takes a long time and the high concentration of the contaminated area is not conducive to plant growth; the microbial treatment needs to consider the screening of the strain and the variation of the environment on the microorganism. At the same time, soil pollution is mainly a composite pollution of a variety of heavy metals, which is difficult to handle.

Therefore, the joint soil remediation technology has gradually become a hot research topic. At present, the technology mainly includes biological joint technology, physical and chemical joint technology and physical chemical-biological joint technology.

The combined repair of plants and microorganisms has achieved good results in laboratory and small-scale restoration. By studying the pollution of soil As by valerian-microbial combination, it was found that Comamonas sp.Ts37 and Delftia sp.Ts41 can significantly reduce the mass fraction of closed As, and the mycorrhizal bacteria can significantly increase the effective As content of soil.

There are also many studies on physical chemistry and joint restoration of plants, such as the greenhouse pot experiment, the horizontal exchange electric field and the induction of EDDS (ethylenediamine disuccinic acid), the study of ryegrass on Cu/Zn in contaminated soil. Absorption, the results show that when combined with exchange electric field and EDDS, Cu/Zn is easy to collect in the middle of the soil, which is beneficial to the absorption of Cu/Zn by plants. The intercalation and chemical leaching were used to study the remediation ability of Zn/Pb/Cd complex contaminated soil. The results showed that after two seasons (about 9 months) combined treatment, the reduction rates of Cd, Zn and Pb in soil reached 27.8%~44.6%, 12.6%~16.5% and 3.6%~5.7%, respectively[40].

Although related research has been carried out on joint repair technology, it has not been applied on a large scale, and the interaction between various technologies has yet to be further studied.

4. Conclusion

In recent years, many heavy metal pollution incidents have occurred in China. These heavy metal pollutions have seriously threatened the lives of the people. Heavy metal pollution in the soil is related to the atmospheric environment and the water environment through the rustic, soil-water interface. Therefore, research on soil heavy metal pollution remediation technology can not only ensure the normal operation of the ecosystem, but also have great significance for the health of the people.

At present, there are many repair techniques for heavy metal contaminated soil, but in terms of single technology, any repair technology has its limitations. In practical applications, the combination of two or more repair technologies can complement each other to achieve a double effect of high efficiency and low consumption. Therefore, when choosing repair technology, we should choose the nature of the pollutant (such as type, shape, concentration, etc.), soil conditions (such as pH, permeability, groundwater level, etc.), the degree of pollution, the expected repair target, time limit, The cost, the scope of application of the repair technology, and the like are selected to select a suitable repair technique or a combination thereof. While looking for suitable technologies for controlling heavy metal pollution, we should also strengthen the control of pollution sources, increase environmental protection, avoid the discharge of heavy metal-containing wastewater into the environment, pay attention to the prevention and treatment of heavy metal tailings, and eliminate heavy metal elements from the source. Soil pollution, actively promote the development of ecological agriculture and green food. In the future, heavy metal pollution in the soil will be developed in the direction of green, stable, economic and wide application.

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